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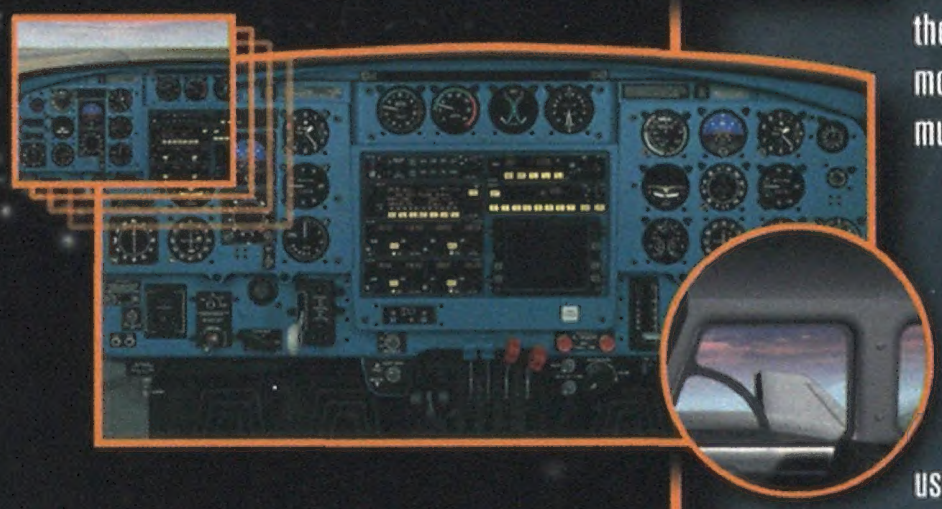

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Volume 14, Number 1

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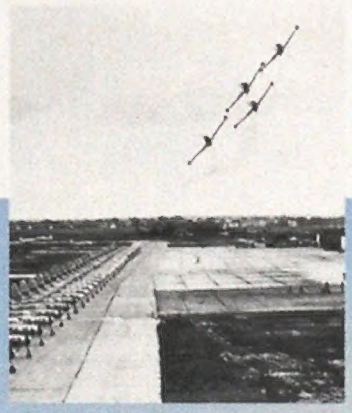
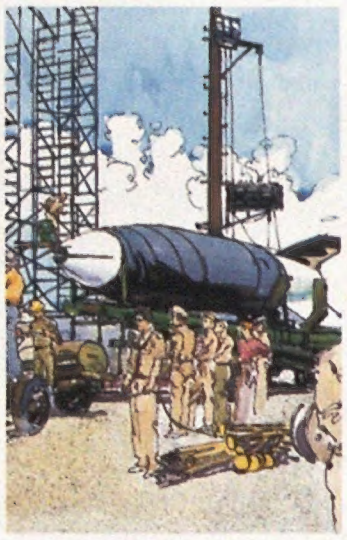


Ringing in the 1999 Airshow Season



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Cover:
Richard Vander Meulen snapped this photo of Anders Brandi bracing himself for the act in Eddie Andreini's Super Stearman.

Departments

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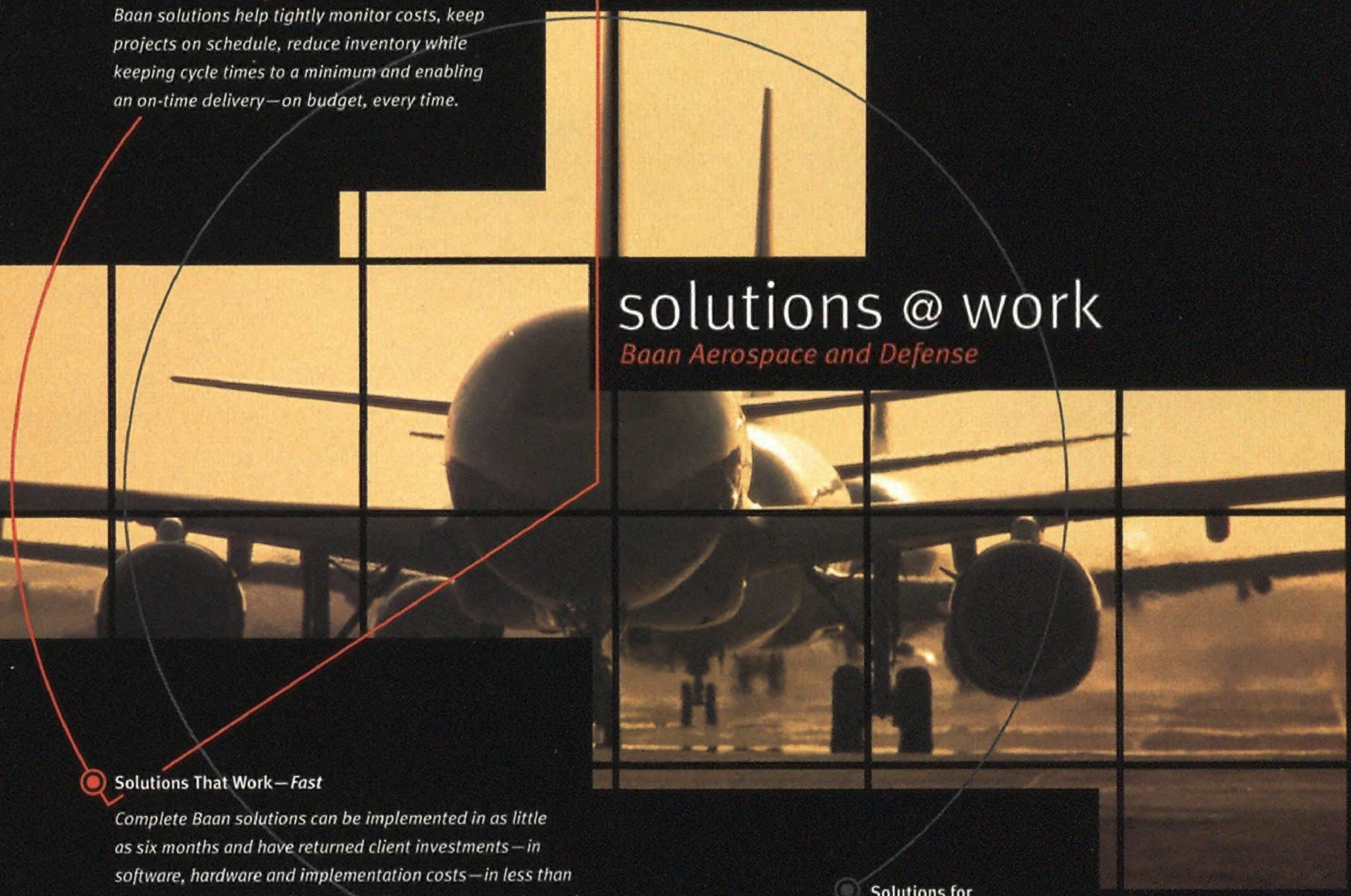

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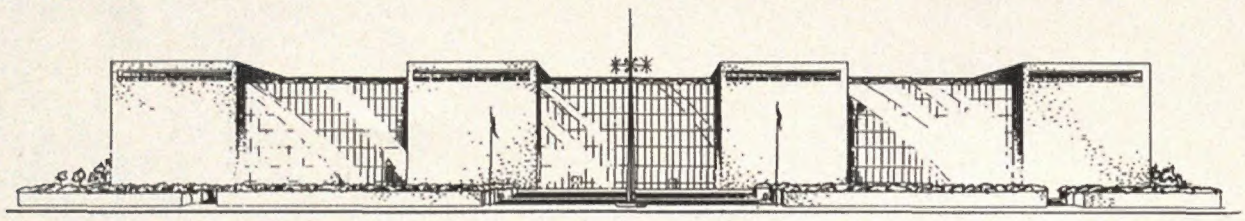

Let the Show Begin

If you like airplanes, airshows have probably played a part in your life; they certainly have in mine. I recall vividly my father taking me to the National Air Races at Mines Field in Los Angeles in 1933. There, Ernst Udet, a German World War I ace, flew his biplane inverted across the field to pick up a handkerchief with a hook on his upper left wingtip. That was a defining moment in my life.

Airshows came hard on the heels of the Wrights' first flight. Until Lieutenant Thomas Selfridge became the first person to die in an airplane crash in 1908, a lot of people had doubts about whether an airplane had even been invented. Selfridge's death made the new machine real, and once the public began to believe in it, the airplane became an object of fascination.

At first the machine itself was the star and the simple act of flight was enough. By 1915 aerobatic maneuvers like the loop, the outside loop, and the "death dive" had been perfected, and the daredevil pilot had become the focus of attention. Entrepreneurs began to realize that public demonstrations would sell tickets, and the airshow was born. In the early days, frequent crashes added a ghoulish element to the public's fascination, but pilots were still encouraged to attempt increasingly daring feats. Pilots being pilots, they did not need much coaxing.

Speed was as thrilling as stunts, and Lincoln Beachey drew crowds when he flew his Curtiss Special against racecar driver Barney Oldfield. Pilots were even asked to heighten the drama by crashing intentionally—and some of them did. The Department of Commerce effectively took control of airshow flying in 1926, when it required all pilots to be licensed. Then the Civil Aeronautics Authority, and later the Federal Aviation Administration, added more airshow regulations.

In the 1940s and '50s, when jets were introduced into the world's armed forces, airshow safety began to take a back seat as sales of a new design became dependent upon a spectacular demonstration flight. International airshows held in places like Paris, London, Dubai, and Singapore included flying performances that were aimed at promoting sales of both military and civil aircraft. Tragic crashes near or into the crowd led to the creation of safety boundaries and rules against flying toward spectators. A pilots' briefing was instituted before each performance to ensure that all participants fully understood the rules.

While there were still occasional accidents, the flying displays grew increasingly spectacular, and during the cold war, U.S. and Soviet aircraft competed for supremacy in titanic aerobatic duels. In the mid-1980s the International Council for Air Shows set its own safety guidelines. Today, performers like Patty Wagstaff and Sean D. Tucker exemplify the highest standards of safety.

Military aerobatic teams such as the Blue Angels, the Thunderbirds, the Russian Knights, Canada's Snowbirds, Britain's Red Arrows, Italy's Frecce Tricolori, and China's Red Angels demonstrate the precision flight that their advanced training makes possible. They also try to drum up support for the services they represent. Who hasn't felt a rush of excitement at seeing these great professional teams perform? Considering the altitudes and speeds at which they fly, it is to their credit that they have made major improvements in safety.

In the United States airshows are second only to baseball as a spectator attraction—and attendance is growing. Events like Oshkosh and Sun 'n Fun are a useful and valuable celebration of aviation. Airshows bring aviation communities together to trade information, conduct business, recruit new people to flying, or just reminisce. Most important, airshows help to inspire us and re-dedicate an aviation nation to the pursuit of its dreams.

I'll see you at the show.

—Don Engen is the director of the National Air and Space Museum.

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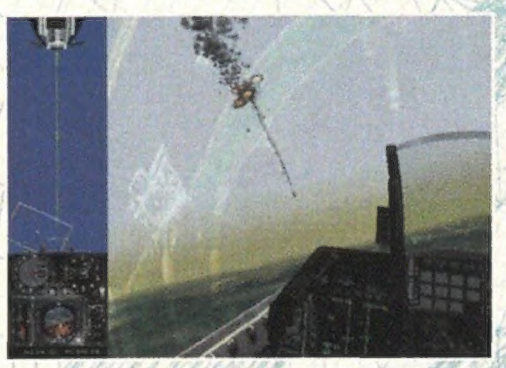
Technically, it's still a computer game.



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LETTERS

High on the 'Hog

I would like to thank the Air Force for not being so "pointy-nose, Mach-snot" crazy ("Old 'Hog, New Tricks," Feb./Mar. 1999). In today's counter-insurgency—oops, better use the politically correct "peacekeeping"—missions, I'd rather have a 30-mm uranium-tipped cannon round smashing into and ripping the top off Ivan's finest tanks than an F-16 zipping by, low on fuel and looking pretty.

—Master Sergeant Wade Kastorff
U.S. Air Force
San Jose, California

There's a proposal now to give some of the 200 retired Hogs a civilian career fighting wildfire (described on the Internet at http://FireHogs.com). Wouldn't it be great if the A-10 joined the Avenger, B-17, F-7, A-26, and other fine warbirds in that lifesaving role?

—Ed Herlik
Colorado Springs, Colorado

The word at Nellis Air Force Base, where the A-10s train, is that the bird is so slow that during checkout flights, the instructor pilots run alongside the plane. It's also said that the plane doesn't fly; the earth repels it. (Still, this old fighter pilot would sure like to fly an A-10. It looks like it would be fun to scoot around in.)

—Harvey L. Brown
Delray Beach, Florida

The Oxcart Cometh Back (for a Few Mid-Course Corrections)

"The Oxcart Cometh" (Feb./Mar. 1999) contains the statement "The B-58 Hustler bomber used fixed spikes in front of its General Electric J-79s." The spikes on the B-58A were actually electro-mechanically actuated and capable of translating fore and aft to vary the engine air inlet area. The position of each spike was controlled by an analog computer.

—Richard Day
San Antonio, Texas

Editors' reply: *We regret the error, which was introduced during editing.*

As the author of three books—including the official history of the Skunk Works for Lockheed—covering the family of aircraft spanning the A-12 through the SR-71, I

Why dogs love unmanned spaceflights

would like to correct "The Oxcart Cometh" as follows:

Project Gusto, a tail-less, all-wing design with two turbojet engines mounted on the sides of the cockpit tub, was, as reported, a proposed successor to the U-2, but it was not the project name for what became the A-12. That was Oxcart.

The B-58B was not named the Super Hustler.

The Kingfish was not a derivative of the F-106; it was a totally original design that had nothing to do with Convair's delta-wing fighter family.

Ramjet technology was not "unproven" at that time; it was used operationally in the Boeing IM-99 Bomarc and the Lockheed X-7, to name a few.

William Burrows is wrong in stating "There is disagreement even today at the Skunk Works on whether the CIA's version was the A-11 or the A-12." Having reviewed various Skunk Works documents, I can tell you that the only designation ever applied to the actual hardware as first flown in 1962 was "A-12." And when referring to the final configuration, Kelly Johnson never used any other designation. In addition, I reviewed drawings of all base Archangel studies, from the A-1 through the A-12, and there was nothing that would cause anyone to confuse the A-11 with the markedly different A-12. It's true that Lyndon Johnson used "A-11" in a 1964 speech unveiling to the world what was actually one of three YF-12As. I have copies of declassified documents in which Kelly Johnson notes that he had asked the president to use "A-11" in order to confuse foreign intelligence bureaus and consequently distance them from the CIA's highly classified A-12.

Burrows states that "hot air [going to the afterburner] arrived at the same speed as the air flowing into the inlet." That implies the air was moving at supersonic velocities. Impossible.

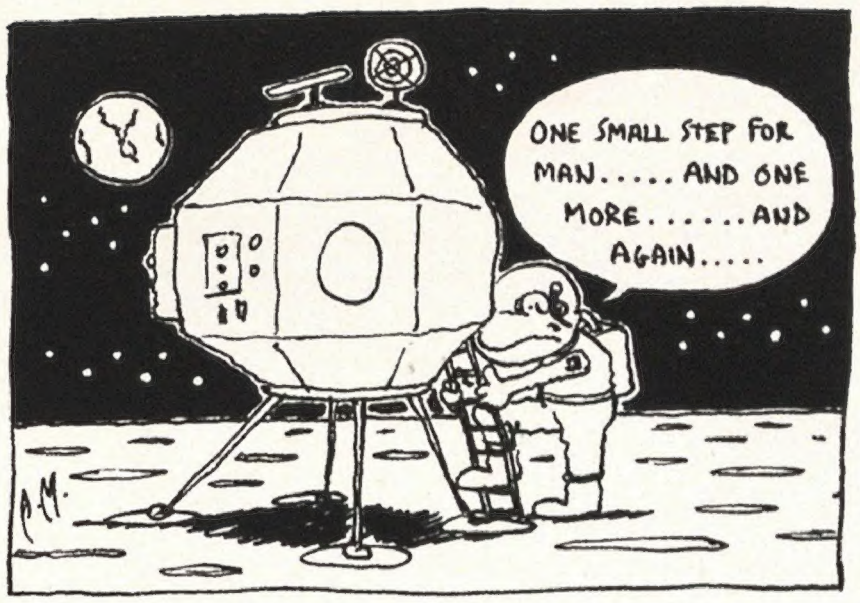
The photo on page 71 was taken at Groom Lake, Nevada, not Nellis Air Force Base.

There is no such thing as an M-12. The two purpose-built D-21 transports were officially designated M-21s. When the M-21 and D-21 were mated, the combination was referred to as an MD-21.

Burrows should have done more research, and *Air & Space* should have run his article through a more professional fact-checking process.

—Jay Miller, Director
American Airlines C.R. Smith Museum
Ft. Worth, Texas

Editors' reply: *The article does not state that Project Gusto and Oxcart were identical. According to Steve Pace's book* Lockheed Skunk Works, *Gusto was a project that had as its goal the development of a high-speed aircraft. When it was canceled, says Pace, Oxcart took up development of the concept.*



The first aerobics instructor on the moon

William Burrows replies: *The Convair material, including references to the B-58B Super Hustler and the F-106, comes from* The U-2's Intended Successor: Project Oxcart, 1956–1968, *which the CIA cleared for release in October 1994 and put on the Internet in March 1996.*

Whatever arrangement Kelly Johnson had with Lyndon Johnson about using "A-11" instead of "A-12" is apparently not known at the Skunk Works today. On July 1, 1997, I conducted a taped interview with Garfield Thomas and Justin Murphy (Murphy flew Sleds and at the time of the interview was the SR-71 program manager), and they made the point that at the Skunk Works, there is still disagreement over the designation. In addition, a National Reconnaissance Office history entitled Management of the National Reconnaissance Program, 1960–1965 *refers to the Oxcart as "A-11."*

Finally, if there is "no such thing" as an M-12, somebody had better tell SR-71 pilot Rich Graham, whose book, SR-71 Revealed *(Motorbooks, 1996), says: "Once modified to carry the drone, the A-12 aircraft were called the M-12." That is also what Ben Rich called it when talking to me on at least two occasions, both of which I taped.*

Days after "The Oxcart Cometh" was published, I read that the Pentagon had cancelled DarkStar, the Skunk Works' unmanned reconnaissance project. Then I learned that United States Representative Howard P. "Buck" McKeon of California is considering legislation to fund the SR-71 again. His office pointed out that the SR-71 could rectify the intelligence disadvantage we face because of DarkStar's cancellation. Are you aware of any factors that could influence Habu's return to service?

—Al Kirschenbaum
Juniper Hills, California

Editors' reply: *The principal obstacle to the Air Force's renewing SR-71 flight operations is the astronomical cost of keeping the aircraft flyable and in a state of operational readiness for on-call intelligence missions. There are other unmanned vehicles undergoing development.*

Not So Fast...

As an ICBM Missile Combat Crew Commander at Malmstrom Air Force Base in Great Falls, Montana, I want to express my anger at the statement that Malmstrom is scheduled to close in 2001 and that it and various other bases "are no longer needed for the nation's active defense" ("Cleared for...Liftoff?," Soundings, Feb./Mar. 1999). What is scheduled to close in 2001 is Malmstrom's runway. The missiles aren't going anywhere. And in its role of nuclear deterrence, the 341st Space Wing here is very active in the nation's defense. While the cold war may be over, there continues to be a threat in a very unstable world!

—First Lieutenant Douglas J. Bayley
U.S. Air Force
Great Falls, Montana

Down the Street and Into the Air

You sure know how to hurt a guy. Just finished reading "Floyd Bennett Field Trip" (Collections, Dec. 1998/Jan. 1999) and really felt my age.

My dad used to take us to Floyd Bennett Field when I was five or six. We lived close: Drive down Flatbush Avenue and there it was. Those visits started my lifelong love affair with aviation. Better stop now before I puddle up.

—R.B. Dunkelman
Miami, Florida

Canada: No Place for Sissies

The Royal Canadian Mounted Police's conversion to the Pilatus PC-12 ("FrigidAir," Dec. 1998/Jan. 1999) raised many eyebrows in Canada, especially given the variety of twin-engine aircraft available. Even though the Pratt & Whitney PT-6 engine has a long record of reliability, there have been two engine failures in PC-12s flying in Canada in the last year, including an RCMP aircraft. Both incidents resulted in forced landings, fortunately with no fatalities.

It seems likely that at some point, the RCMP themselves will be the subject of a search for a downed PC-12 somewhere in the vast north. Flying with no redundancy

AIR & SPACE CONTEST

Unidentified Flying Object

CAN YOU IDENTIFY THIS AIRPLANE?

The airplane pictured above is a:

- Transavia PL-12 Airtruk
- Rockwell C-176B Grackle
- PZL-126 Mrówka
- Nipper Mk III

For the third in our series of six contests, we've made the task a little more difficult than the first two. But the rules haven't changed: You can qualify for six prizes, one of which will be awarded after each photograph is published, and one grand prize at the conclusion of the contest:

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All you have to do is select an answer from the choices listed above, then mail a postcard with your name, address, and answer to: AIR & SPACE, UFO Contest, 901 D Street SW, 10th Floor, Washington, DC 20024. Identify the airplane correctly and you'll qualify for the drawing to award the prize.

Before entering, please read the detailed rules, which are posted on page 83.

WINNER WINNER WINNER WINNER WINNER

Winner of the first UFO Contest is **MICH YOSHII** of California, who was among hundreds of readers who correctly identified the object in the photograph as a French high-speed research aircraft, the **Leduc 022**.

in northern Canada in the winter is asking for trouble. Fleet acquisitions based primarily on economics (which the RCMP decision appears to be) can sometimes come back to haunt the decision-makers.

—Rod Ridley
Winnipeg, Manitoba

"FrigidAir" refers to the fact that pilot Wilfred "Wop" May was instrumental in the capture of the "Mad Trapper" who was fleeing from law enforcement officers. Your readers may be interested to learn that May was also awarded the McKee trophy for the advancement of Canadian aviation, in part for delivering diphtheria serum in 1929 to Fort Vermilian, Alberta, in an open-cockpit biplane in temperatures that dropped to –40 degrees. His delivery averted an epidemic.

However, May is best remembered as the pilot that Baron von Richthofen was pursuing on that day in April 1917 when he himself was killed. A controversy still exists over who deserves the credit for shooting down von Richthofen and thus saving May, but there is no doubt that the residents of Fort Vermilian and one Royal Canadian Mounted Police officer owe their lives to the fact that May survived his encounter with the Red Baron.

—David Barlin
Marlboro, New Jersey

A One-Man Bird

I got a kick out of the piece on the mechanic who got stuck in the AD-1 ("Squeeze Play," Above & Beyond, Dec. 1998/Jan. 1999). However, that airplane was a single-occupant bird, unlike the one in the illustration. Having been a Navy pilot in the late 1950s, I recognized the plane in the picture as my old friend, the Douglas AD-5.

—Bill Happersett
Walnut Creek, California

When Bad Things Happen to Good Kites

The attackers who used kite line coated with powdered glass to bring down other people's kites ("Strings Attached," Soundings, June/July 1998) may have been inspired by the original Boy Scout, Daniel Carter Beard. His *American Boys' Handy Book*, published in 1882, gives detailed specs for war kites, both armed and unarmed. The National Park Service personnel on the lookout for the modern-day kite attackers may be comforted by Beard's caution to Victorian youth:

"...there is no honor or glory to be gained in vanquishing a foe who is unable to defend himself."

—Lt. Col. Robert T. Sweeney
U.S. Air Force (ret.)
San Francisco, California

How Green Was My Tractor

You always strive to represent machinery of transportation authentically. Why then did you depict Troy Fehring's tractor ("Talk Radio," Feb./Mar. 1999) in International Harvester red instead of the appropriate John Deere green? I am sure this oversight was due to your relative unfamiliarity with slow, ground-based vehicles. However, this is one more reason many readers prefer crisp photographs to squiggly cartoons.

—Shawn Shianna
Freeport, Illinois

Aviation's Big Turn-Off

"High Society" (Feb./Mar. 1999) enlightened me on a lot of things that happened at the Aviation Country Club of Long Island before I worked there. But the article had a few miscues. The Stinson I started for Lindbergh was a Voyager, not a 105, and during that procedure, I said "Switch *off*, gas on, brakes on." If the switch was on while the engine was being primed, the mechanic might lose a few fingers or worse.

—Alfred H. Merrill
Collinsville, Virginia

A Fuelish Claim

The article "More Bang, Big Bucks" (Soundings, Feb./Mar. 1999) states that the Germans used kerosene and hydrogen peroxide as the propellant and oxidizer, respectively, in their V-2 rockets during the Second World War. The V-2 was, in fact, fueled by a mixture of alcohol and water; the oxidizer was liquid oxygen. Hydrogen peroxide was used to drive the turbine pumps for these chemicals.

—Ivan C. Snell
Blythewood, South Carolina

Attention BUFF Buffs

The B-52 Association is seeking to expand its knowledge about the B-52D on display in the Air Force Museum in Dayton, Ohio. We know that on April 8, 1972, it survived a hit by an SA-2 surface-to-air missile. Badly damaged, the aircraft recovered at the nearest friendly field, Da Nang air base. It was quickly patched together for a one-time flight back to U Taphao, where repairs were completed. It reentered service, taking part in the Eleven-Day War a few months later.

It's inconceivable to me that this airplane could have sat on the ramp at Da Nang for even a few hours and not be photographed by scores, if not hundreds, of bored airmen and marines. We would really appreciate the loan of any good pictures, which we will handle carefully, copy, and return. We also need anecdotal material about the incident. Finally, we'd very much like to hear from any of the crew on that April 8 mission.

—Col. Wayne C. Pittman, USAF (ret.)
B-52 Stratofortress Association
498 Carthage Dr.
Beavercreek, OH 45434
phone/fax: (937) 426-1289

Corrections

Feb./Mar. 1999 "Signatures From Earth" (From the Field): "DVD" originally stood for Digital Video Disk but now stands for Digital Versatile Disk. (The error was introduced during editing.)

June/July 1998 "Higher Calling": The Hindu god with whom the trident is associated is Siva, not Vishnu.

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"Hey Sam, do we have a bug shield for ultralights?"

Kaman Decision

Charles Kaman was the last of his breed: an aviation pioneer who still sat in the CEO's chair in a company he founded. He was unique too; in aviation biology the pioneering gene rarely mixes with the business gene. Both Curtiss and the Wrights had departed their eponymous companies well before those companies merged and then sank beneath their combined weight; William Boeing bailed out while his was still a modest enterprise; so too did Clyde Cessna slip away from Cessna Aircraft. Late last year Charles Kaman announced that he was stepping down as chief executive officer of Kaman Corporation—after more than a half-century at the helm—due to declining health.

During his tenure the 79-year-old Kaman had parlayed $2,000 from friends and a wacky idea about making helicopters easier to fly into a $1 billion international conglomerate (see "The Taming of the Copter," Dec. 1990/Jan. 1991). According to company legend, Kaman took the plunge into proprietorship in 1945, when, as a young engineer working for United Aircraft, he made something of a pest of himself trying to get company managers interested in his innovative servo-flap rotor design, which would help make the primitive helicopters of the day easier to control. But United wouldn't bite. Kaman asked to be released from his contract, and his company was born.

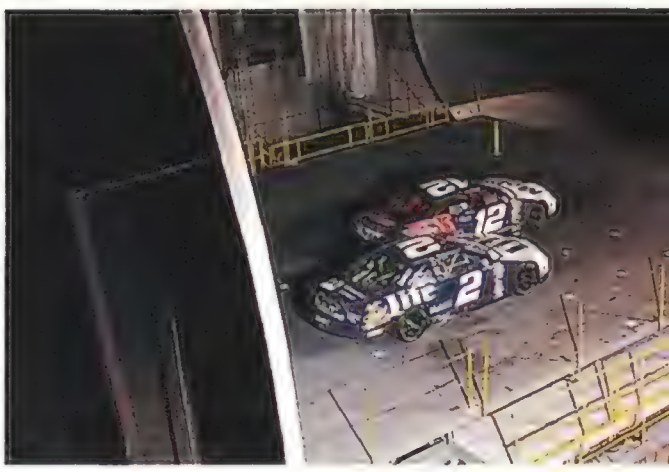
Within two years his first helicopter, the K-125, took to the air with the servo-flap device and his now-trademark twin intermeshing rotor design, which added lift while eliminating the need for a tail rotor. To raise capital for the fledgling company, test pilot Bill Murray would fly aerobatics in the machine on Sundays while the rank-and-file employees sold stock to the crowds that gathered. Kaman used that capital to pay those employees, and to install a turbine engine in the helicopter—the world's first such combination, which now resides in the National Air and Space Museum. Today the only helicopters flying without turbine powerplants are wheezing museum pieces.

KAMAN CORP.

None of this would have happened if Charlie Kaman hadn't turned down a heady $75-a-week gig with one of the leading big bands of the pre-World War II era. "When he was in his late teens he actually had a tryout with Tommy Dorsey," says company spokesman David M. Long. "He was offered a job as guitarist, but he decided that his heart was really in engineering."

—Phil Scott

CHUCK THOMAS/OLD DOMINION UNIVERSITY



How Dale Earnhardt Slicks Back His Hair

Since it opened in 1931, the colossal full-scale wind tunnel at NASA's Langley Research Center has been used to evaluate everything from rag-wing biplanes to the F-22, Mercury space capsules to an inflatable airplane that shredded during testing, even a submarine and another wind tunnel.

But of all the weird and wonderful programs that have blown through the tunnel, none is more antithetical to the purpose of the facility's creators than the ones going on right now: The whole point is no longer putting vehicles into the air; it's keeping them planted on the ground.

For the past year, the tunnel has been engaged almost exclusively in testing race cars. More than two dozen teams have rented the facility at an hourly cost of up to $1,400, often testing two cars simultaneously to gauge the effects of passing and drafting. Says Eric Warren, chief engineer for the Penske Racing South and Penske-Kranefuss Racing Winston Cup teams: "Aerodynamics is one of the few areas [of racing] that hasn't been fully exploited."

The tunnel's builders would no doubt be nonplussed to find race cars occupying the space once reserved for aerospace exotica such as the supersonic transport. But without race car testing—and the vision of Jim Cross—the tunnel would be the biggest white elephant in Hampton, Virginia.

When it opened, the tunnel was the largest and most sophisticated in the world, with a pair of four-blade 35.5-foot propellers powered by two 4,000-horsepower motors capable of generating wind speeds of 120 mph. Although it's called a 30-by-60-footer—referring to the test section—the actual tunnel is 434 feet long, 222 feet wide, and 97 feet high.

Big as it was, it was eclipsed in 1944 by a 40- by 80-foot tunnel built at what's now NASA's Ames Research Center in California. And when budget cuts forced the closure of numerous NASA wind tunnels in 1995, the Langley facility got the axe.

That's when Cross, then dean of Old Dominion University's College of Engineering in Virginia, got in the act. Although the Langley tunnel was no longer state of the art, he figured it could meet the needs of the dozens of NASCAR teams headquartered in nearby North Carolina. After two years of negotiation, NASA agreed to let Old Dominion run the tunnel. Cross now serves as its manager and principal salesman.

The tunnel's biggest selling point is just that: size. "It's truly awe-inspiring," says Kevin Doran, owner of Doran Racing, whose Ferrari 333SP raced at Le Mans after testing at Langley. "It means you can test a car instead of spending three months and $100,000—or more—building a model."

Race aerodynamicists focus on drag, which slows cars down, and downforce, which helps them corner faster. The tunnel was already optimized for drag-reduction analysis; virtually every American fighter of World War II benefited from Langley "cleanup" studies. Measuring downforce at the tires, on the other hand, required new equipment.

Although Old Dominion has upgraded and modernized the tunnel, it's still not cutting edge. Its biggest deficiency is the lack of a so-called rolling road, without which it's impossible to analyze the aerodynamic properties of the bottom of a car—an area of critical importance in open-wheel formulas.

Meanwhile, Cross is searching for business anywhere and everywhere. "Fewer and fewer new airplanes come along these days," he says. "But Rubbermaid was just here. They were testing a garden shed. We blew on it until it blew apart."

—Preston Lerner

Snakebit

You never know what sort of exotica you're going to see at California's Edwards Air Force Base, the world's busiest flight test center. But on a gloomy afternoon in February, it was nothing but F-16s—105 of them arrayed in orderly

AIR FORCE FLIGHT TEST CENTER (2)

rows on the ramp and another five flying in formation overhead.

After a brief but dazzling airshow by a sixth F-16, nearly 2,000 well-wishers gathered in Hangar 1600 to salute an airplane that's been confounding expectations ever since the General Dynamics YF-16 prototype inadvertently made its first flight during a high-speed taxi run 25 years ago.

"All I can think of is the skeptics who told me that the airplane wouldn't go anywhere or carry anything, that it wasn't good for anything but airshows at county fairs," said chief designer Harry Hillaker, a white-haired man as compact, nimble, and defiant as the fighter he developed in the face of widespread criticism.

At Edwards, of course, Hillaker was preaching to the choir. Joining him at the reunion were hundreds of engineers, craftsmen, and pilots whose lives had revolved around the F-16. Swaggering around in their flightsuits, the Air Force aviators looked more conspicuous. But nobody had better stories to swap than retired General Dynamics project pilot Phil Oestricher, who flew both the first and last flights of the two prototypes.

"It was the program of a lifetime," Oestricher said. "The high-speed taxi was a real adventure: It showed that we had a *major* flight control problem. But after we fixed it, the first official flight was wonderful. The YF-16 outperformed the chase airplanes [an F-4 and two T-38s] and ran them out of fuel at the same time. It was obvious right away that the airplane was light-years ahead of the competition."

As it turned out, the world's first fly-by-wire fighter would be widely produced—3,800-plus and counting. At the moment, the F-16 is flown by 19 countries. None has been destroyed in aerial combat, a record that should come as no surprise to those familiar with its pedigree.

As Hillaker related the story, the F-16 grew out of a heated argument he had with an Air Force renegade by the name of John Boyd. The leader of the so-called "Fighter Mafia," Boyd despised the ungainly F-111 (another General Dynamics product) and espoused a novel (and unpopular) theory of air-to-air combat tactics that placed a premium on light airplanes that could turn and accelerate quickly.

Before long, Boyd and Hillaker were working together to develop an airplane that embodied Boyd's thinking. Extraordinarily agile, with a seat reclining 30 degrees and a canopy offering panoramic views, the F-16—now built by Lockheed Martin—is a fighter pilot's dream. "It's the best plane ever manufactured," Air Force Captain Dave "Spock" Youtsey declared as he watched the festivities. "It does everything and it does it well."

F-16 drivers have just one problem with the airplane: its official name. "Fighting Falcon," Lieutenant Colonel John Simonetti muttered, looking pained. "In my squadron, if you call it a Falcon, you've got to buy a round of drinks." The preferred name, Simonetti said, is Viper. After 25 years, this is one snake that's still as lethal as ever.

—Preston Lerner

Short Skirts

If you're sick and tired of hearing "faster, better, cheaper," take heart. NASA rocket scientists are chanting a new mantra: reboost, reuse, recycle.

Last year NASA found itself running short of a particular solid-fuel rocket booster segment for the shuttle. Rather than crank up long-idle production lines to

build more, the agency repossessed two segments from an outdoor museum display at Marshall Space Flight Center's U.S. Space and Rocket Center in Huntsville, Alabama.

Marshall's tourist attraction sports a full-scale orbiter, external fuel tank, and twin boosters angled skyward. The boosters' two forward skirts—the topmost cylinders, just below the nose cones, where all booster electronics are housed—are the only pieces of flight hardware still considered usable. Last March, they were replaced with Fiberglas.

For about $600,000, NASA had real hardware—actually a pair of test articles—brought up to flight quality and back in the inventory in time for a launch next year. Asked a former shuttle pilot on hearing the news: "Whose crazy idea was that?"

Roy Runkle's. He's the structures subsystem manager in the solid rocket booster chief engineer's office at Marshall. His job is to figure out how to economically rebuild the forward skirt inventory.

NASA bought a total of 28 reusable skirts in the 1970s, expecting them to last for the life of the program, which was estimated at 25 years. Fourteen flight sets seemed more than enough, so a few years later the agency gave one set to the U.S. Space and Rocket Center. But now shuttles will be flying another quarter-century into the future, and NASA has only 17 forward skirts left. Two sank in the Atlantic Ocean off the coast of Florida in 1982, two exploded with *Challenger* in 1986, and since 1990 five have been damaged on splashdown. Only four of those can be repaired. "We realized we weren't going to make 2030," says Runkle.

In the spring of 1998, when Runkle was returning from a visit to the shop where Serial No. 22 was being repaired, the solution "slapped me in the face," he says. "As I drove back to the Space and Rocket Center on 565, I looked over and saw the display. I said, 'There's two perfectly good forward skirts. Why aren't we using those?' " Estimated savings over building new units: $12 million.

The loan agreement with the U.S. Space and Rocket Center had left NASA an out. " 'For programmatic purposes' is the way it's worded—which could mean for flying in space or for test articles or whatever—so that we could get them back," says John Chapman, deputy manager of Marshall's booster project.

Structural integrity isn't a concern. Chapman says several years' worth of exposure to the elements is "considerably less stressful" than the boosters' flight profile—from zero to Mach 5 in a matter of seconds, a 40-mile fall, and a 60-mph water impact. And other than the inconvenience of making the switch, "it will have no impact on the museum display," says U.S. Space and Rocket Center president Mike Wing. "It serves to underscore the idea that items here are of considerable historical significance."

—Beth Dickey

Last Call

A MiG pilot introduced me to Trader Jon's. Okay, he wasn't actually an Ivan. Paul Entrekin was a straight-up ex-Marine acquaintance who'd gone through flight training at Pensacola Naval Air Station and later, as an entrepreneurial civilian, had bought a MiG-15 that he flew for big bucks at airshows. But I'll bet that even in Russia there are fighter pilots who know Trader Jon's, the Pensacola, Florida bar that is as much a part of Naval aviation as are carrier qualifications, the Dilbert Dunker, and Tomcat pukes. Trader's was

the frat house for every aviator who got his or her wings of gold at Pensacola.

Of the hundreds of photos on Trader's wall—gun camera frames of Vietnam kills, snaps of cavorting astronauts, priceless pictures of quiet but monumental aviation milestones—my favorite, though the details are seen through a haze of time and beer, I remember as a standard graduation shot of two dozen newly minted ensigns in front of their T-2 Buckeye trainer. Everybody was in flight-suits and helmets, opaque green-black glare-shields down, two rows of anonymous insects. Except for the woman third from the right, second row, who wore nothing.

Trader's is a monument to political incorrectness. The saloon is strewn with the memorabilia of the arrogant masculinity that is Naval aviation: aircraft parts, crash helmets, uniforms, insignia, flags, models, and what is purported to be Amelia Earhart's skeleton, as well as an entire room filled with Blue Angels artifacts.

Last time I was at Trader's, in the fall of 1997, I'd stopped by to give Martin Weissman (Trader Jon) a West Point banner for the walls, which he'd insisted on having when he learned that I lived in the shadow of the rival military academy in the Hudson River Valley. But Martin wasn't there. He'd had a stroke days

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earlier. His wife, Jackii, was running the bar, but since then, Weissman, now 83, has become partially paralyzed and unable to speak clearly. Jackii has closed the bar, and the Weissmans need to sell it.

To keep this museum-hiding-in-a-saloon from being turned into a miniplex or a Planet Hollywood, ex-Marine helo pilot Kent Bolin and ex-Blue Angels leader Bob Stumpf, now a FedEx pilot, have formed the Trader Jon's Preservation Squadron (TRAJONPRESRON in Navyspeak) to raise enough money to buy the bar and reopen it unchanged. If you'd like to enlist, contributions go to Trader Jon's Preservation Squadron, Inc., c/o First Navy Bank, 180 Taylor Road, Pensacola, FL 32508. The effort's Web site is www.traderjons.com, or you can leave a message at (850) 969-3026.

—Stephan Wilkinson

The Engine Room

MARK GODFREY (2)

Bill Surgi, Norm Taylor, and Maurice Goodwin are midway through a seven-year project to clean, preserve, and build stands for the National Air and Space Museum's engine collection, which includes the Dusenberg King-Bugatti that Taylor is working on and a 1917 Rolls-Royce (right).

If you know where to look at the Paul E. Garber Preservation, Restoration and Storage Facility, you can find Norm Taylor and his two volunteers hard at work. First, find a whole stack of airplane engines. Hidden behind some heavy curtains that mask the ultraviolet emissions from his arc-welding rig, Taylor and his merry men are busy building engine stands for the National Air and Space Museum's propulsion collection. Under the curatorial direction of Rick Leyes, the collection is being prepped for the day when, in its entirety, it will greet the public for the first time at the new Dulles Center, scheduled to open in 2003.

Most of the engines in the collection are stored in packing crates or simply sitting on shelves; few have been mounted on stands, which are like engine mounts but designed to facilitate storage and movement. The effort to build the stands has been supported by a grant from the Pratt & Whitney division of United Technologies Corporation. Plans call for the engines to go on view throughout the Dulles facility, each one positioned near an airplane it once powered. Before that can happen, though, the engines have a long road to travel.

"The oldest ones have been here since around World War II, some just lying on mattresses," says Taylor. "The radials are mostly stored in the vertical position, with their prop shafts up. [On the new engine stands] all of them will be in the flying position." Each stand has to be custom-designed so that existing mounting hardware on the engine can be bolted to a matching support on the stand, with a cushioned support for the propeller shaft. When temporary casters are inserted into pipes welded to each stand for the purpose, the engines are easier to move around without special equipment like a forklift, making life just that one bit sweeter for the Garber staff.

Taylor left the U.S. Army after 22 years as an electronic warfare technician and, as he tells it, "went to Tennessee to go visit my brother and do a little deer hunting." While he was there, he took a course in welding that is now paying off for the engine collection. His two volunteer assistants, both in their 70s, are Maurice Goodwin, a former Royal Air Force gunner, and Bill Surgi, a retired U.S. Navy aircraft mechanic from New Orleans. Over daily lunchtime games of cutthroat Trivial Pursuit, Taylor's Middle Amurrican rumble forms the bass line to Goodwin's working-class Brit accent and Surgi's N'awlins drawl. Of his helpers, Taylor says, "They come in here and put in a full day's work, more than should be expected of them." Of their senior status, Goodwin says with a chuckle, "The nice people at Pratt & Whitney refer to us as 'the elderly gentlemen.' "

The work can be dirty. The older engines are covered in cosmolene, a sticky tar-like preservative that has been replaced by more environmentally benign waxes, or, to be exact, "cortex vapor phase inhibitors in a microcrystalline wax base" (Surgi has written down for the inquisitive visitor the precise words on the package). Their first task is to measure the engine and determine the dimensions for the stand, which will be cut from steel I-beams, angles, and pipes. When mounting holes can't be measured with a rule, the workers drop a plumb line through the holes, mark the spots, and

then measure the inter-hole distance using the marks. Taylor takes the numbers and heads upstairs to a computer-aided design station. The computer performs much of the dimensional calculating and prints out a template so that locations can be marked directly on the engine-stand-in-the-making. From the drawing, Taylor cuts his bar stock with a plasma torch and begins assembling the parts. Goodwin and Surgi cut some of the smaller parts with a saw.

They use any of a number of overhead hoists to help lift the engines, ranging from less than 100 to more than 3,000 pounds, and rotate them from their sitting position to the orientation they would be in when mounted on an airplane. Goodwin and Surgi have also adapted an ancient technique they call "Egyptian rollers"—a series of poles on the floor placed under the load to roll it into tight quarters. The two volunteers also help clean the engines by washing them down with mineral spirits (paint thinner), cleaning away any area of corrosion, and spot-spraying with preservative coatings. They cover all openings that could provide access to humid air and install desiccant (moisture absorbent) plugs in the spark plug holes.

Following Leyes' list, which gave highest priority to the oldest engines in the worst shape, they've completed 135 stands since the project began in 1995. Taylor says he is now cranking out an average of about 40 stands each year and hopes to have the project completed six months before the Dulles Center opens. His reward? "In the future maybe my grandkids will see it," he says, "and they'll say 'That's what grandpa did.' "

—George C. Larson

When not being worked on, the engines, including this Mitsubishi HA-43-1 radial, are stored on shelves in Building 30.

Museum Calendar

Except where noted, no tickets or reservations are required. To find out more, call Smithsonian Information at (202) 357-2700; TTY (202) 357-1729.

April 7 Exploring Space Lecture: "Measuring Cosmic Evolution with the Hubble Space Telescope." Harry Ferguson, an astronomer at the Space Telescope Science Institute in Baltimore, will discuss his work, which involves comparing theoretical models of galaxy evolution to the distribution of galaxy size, brightness, and colors seen in images recorded by the Hubble Space Telescope. Einstein Planetarium, 7:30 p.m.

April 10 Astro-Consumer Clinic: "Binoculars! Telescopes! Astronomy!" Learn from local experts how to wisely choose, use, and care for astronomical instruments. Milestones of Flight gallery, 10 a.m. to 4 p.m.

April 22 G.E. Lecture: "Flying Tiger Colonel Ed Rector." Edward Rector will recount his story as an ace fighter pilot in China during World War II. Langley Theater, 7:30 p.m.

April 24 "When Galaxies Collide." John Wallin of the Institute for Computational Sciences and Informatics at George Mason University will talk about the cosmic equivalent of traffic accidents. Einstein Planetarium, 6 p.m.

April 27 Wernher von Braun Lecture: "Godspeed...Space and the American Dream." John Glenn will reflect on his life as a pioneering astronaut, a U.S. senator, and then an astronaut again. For ticket information, call (202) 357-4574. Langley Theater, 8 p.m.

May 5 Exploring Space Lecture: "Images from the Hubble Space Telescope: Delight at the End of the Tunnel." Sandra Faber, an astronomer at the University of California at Santa Cruz, will give a tour of the universe using some of the Hubble's most arresting images. Einstein Planetarium, 7:30 p.m.

May 29 Monthly Star Lecture: "Exploring the Moon." Jim O'Leary, director of the Davis Planetarium at the Maryland Science Center, will explain why the moon is an object of enduring interest. He will also preview June's night skies. Einstein Planetarium, 6 p.m.

RENAISSANCE MAN

GEORGE HALL/CHECK SIX

On May 20 at 8 p.m., Clay Lacy will speak at the National Air and Space Museum's Langley Theater, detailing his long career in aviation. Lacy has been a movie pilot, experimental test pilot, air race champion, and entrepreneur. His company is not only a jet charter outfit but also a leader in the field of aerial cinematography. Since 1965, Lacy's three specially equipped Learjets have shot footage for airlines, the military, and over 100 television and film projects, including Top Gun. *For more information, call (202) 357-2700; TTY: (202) 357-1505.*

National Air and Space Society

As a Founder Member you can help support the most significant effort in the National Air and Space Museum's history: the new Dulles Center, to be built at Washington Dulles International Airport. For information, call (202) 357-3762 or write to: The National Air and Space Society, NASM, Room 3608, MRC-310, Smithsonian Institution, Washington, DC 20560; e-mail: nass@sivm.si.edu

MiG Fever

June 15, 1953. Red Flight, consisting of four F-86 Sabrejets, had just started a gentle turn south when suddenly the aircraft radio came alive. "Red Four has friendlies closing at five o'clock."

The mission was a combat patrol along the Yalu River, which separated North Korea from Communist China—MiG Alley, we called it. Red Flight was "conning," leaving white condensation trails at 45,000 feet, rendering it highly visible against an azure sky. The flight leader was Captain William Champion, who was closing in on 100 missions. First Lieutenant James Sawyers was Red Two, Champion's wingman. Red Three was First Lieutenant William Mailloux, who was nearing the end of his combat tour. Red Four was First Lieutenant Richard Frailey, a veteran of 65 missions.

Following Red Four's uneasy call, Champion began turning his flight into the pursuing Sabrejets. He tightened the turn to make them overshoot, or even better, recognize the Sabrejet's distinctive silhouette. Still they continued to close. Incomprehensibly, the attackers had to have been friendlies, since the only other flight on combat patrol that afternoon was led by Major James Jabara, a squadron executive officer who was near triple-ace status with 13.5 MiG kills.

"Never let anyone track you at six o'clock, even friendlies," a flight instructor at Nellis Air Force Base in Nevada had told us. "You can never tell when someone has MiG Fever." This, we learned, referred to an overeager pilot who had mistaken a swept-wing F-86 for a MiG-15. Shortly after my arrival as a member of the 334th Fighter Interceptor Squadron at Kimpo Air Base in January 1953, a senior pilot shot down and killed a lieutenant from a sister squadron, so I knew MiG Fever was real.

NASM (2)

Separated at birth? The F-86 Sabrejet (top) and the MiG-15 (above) were similar enough, particularly at a distance, to cause a case of mistaken identity—MiG Fever—in overeager U.S. Air Force pilots in Korea.

The 334th was the original Royal Air Force Eagle Squadron, which had become famous in World War II as a unit of American volunteers who had served in the Battle of Britain. It had also proved its effectiveness as a combat unit in Korea. By March 1953, the squadron had three jet aces: Captain Leonard W. Lilley, Captain Manuel Fernandez, and Jabara, the first U.S. Air Force jet ace. With the war winding down, a fierce competition developed for the title of both triple ace—15 kills—and top ace. Fernandez and Captain Joe McConnell of the 51st Fighter Interceptor Wing were leading, with Jabara in third place. Fernandez and McConnell were skilled tacticians and masters of fighter tactics in the F-86. Jabara was an excitable street fighter who would fearlessly wade into the fray. By June, Lilley had completed 100 missions, and with seven MiG kills, he returned home, as did Fernandez, who had 14.5 kills.

Jabara had a problem that was well known to several of his wingmen: He could not see well. He had a preference for sharp-eyed lieutenants who would vector him toward an enemy aircraft and who would hang onto his wing regardless of the intensity of his maneuvering.

Dick Frailey was one of Jabara's favorites. Despite having passed the 50-mission mark, where one became an element leader and could now fire his guns, Frailey was still regularly scheduled as Jabara's wingman.

On one mission I overheard Frailey call Jabara, "I've got two spinners, one at nine o'clock and one at 11." He was referring to two MiG-15s at 50,000-plus feet, an altitude the F-86 could not comfortably reach. Occasionally, low-time MiG pilots would inadvertently stall and begin spinning from altitude. Pilots would often eject in panic at high altitude, rendering their chance of survival slim. Because the MiG could not recover from a spin, an F-86 pilot who first spotted a spinner was traditionally given credit for a kill. In this case, Jabara, who was desperately trying to up his score before the war ended, said, "If I've got a good wingman, I've got two kills."

"If I've got a good leader, I've got one and you've got one," Frailey shot back. Alas, Jabara took credit for both MiGs.

On another occasion, as my flight was returning from a fighter sweep, I overheard Jabara and his flight on the

squadron frequency engaged in a heavy-breathing dogfight. During our 30 minutes of patrolling MiG Alley, the radar station had reported that nothing was flying. But Jabara had stumbled into MiGs—probably, I figured, at one of the Chinese airfields.

Another flight commander who had just arrived in the patrol area overheard the ongoing battle. "Where are you, Jabbie?" he transmitted. "We'll come give you a hand."

"Don't bother," Jabara responded breathlessly. "There's just enough for us."

On that day in June, I passed Frailey as he left the personal equipment room dressed in G-suit, life vest, and parachute. On his chest, secured by parachute cord, was a camera with a telephoto lens. "I intend to be the first pilot in the Air Force to take a still photo of a MiG-15 in flight," he told me.

Because Champion was nearing his 100th mission without having scored, he took Red Flight on a wide sweep near a MiG-15 training base. Crossing the Yalu River boundary had become fairly common during the latter stages of the war. Chinese airspace had been placed off limits by what we combatants considered ill-conceived policy. Thus, the lighter-weight MiGs could climb well above their F-86 adversaries in sanctuary, then cross into North Korea to engage them with a significant altitude advantage. Then, too, at this late stage of the war, there were often long periods when the MiGs were not flying. Thus Red Flight's four white contrails, well into Chinese airspace, were conducive to an acute case of MiG Fever.

Tenaciously, Jabara pressed his attack on Red Flight. "The attacking flight leader seemed to be tracking Red Leader," Frailey said later, "then Red Two, Red Three, and finally, because of the increasing angle, he locked onto me. His opening burst was at long range, maybe 3,000 feet. Although the initial bursts missed, the first hits were on my left wing—it sounded like heavy rain on a tin roof. The second punched holes in my canopy and shattered the instrument panel—the cockpit was filled with debris. Then the final burst hit the engine."

The Sabrejet went into a spiral dive. "The hydraulic flight controls were very sluggish," Frailey said. With great effort he regained control and continued south.

The radio was alive with frantic shouts. "Cease fire! Cease fire! We've got friendlies firing at Sabres!" The calls broke Jabara's concentration, and he finally stopped firing.

With only 78 percent engine rpm, Frailey began a slow drift toward the confluence of the Yalu River and the Yellow Sea. Fortunately, the radio still worked. Red Three was now flying beside the badly damaged Red Four. "You're

COURTESY JOHN LOWERY

James Jabara, William Mailloux, and Richard Frailey (left to right) were a band of brothers in MiG Alley territory—until Jabara scored his 16th kill.

smoking pretty bad," Mailloux radioed. "Looks like from here you'll have to leave it. We'll try to make the sea."

Jabara too had brought his flight into a protective position on the wounded F-86F. "I don't want to eject," Frailey said in jest. "I've got my new camera with me."

"Screw the camera," Jabara replied. "I'll buy you a new one."

Once over the Yellow Sea, with heavy smoke billowing into the cockpit, Frailey transmitted, "She's not going any further. I'll have to go." And with that he ejected.

Once out, he began tumbling. The wind caught his helmet and pulled it back, causing the oxygen mask to ride up over his eyes. Frantically he tried to find the seat belt release. After an eternity, he found the buckle, pulled the release, and kicked hard to get free of the seat. He pulled the D-ring release and the parachute snapped open. With that, his feet hit the water. "I immediately got tangled in the parachute," he said. "After what seemed like forever, I got free and pulled the lanyards on my Mae West." But the vest wouldn't keep him afloat. He would later discover that a .50-caliber bullet had passed between his arm and chest, then ripped open the air bladders. "I had just inflated the one-man life raft and was struggling to climb aboard when I looked up and saw an Air Force Albatross taxiing toward me."

Having landed within range of North Korean and Chinese shore guns, there were deadly splashes all around Frailey and the Grumman SA-16 Albatross as the enemy tried to find their range. The amphibian hurriedly plowed alongside. Then someone threw Frailey a life preserver and began pulling him in. As he bumped the side of the Albatross, two sets of arms snatched him aboard. With his legs still dangling through the open hatch, Frailey heard a thunderous roar as the pilot simultaneously applied full power and fired the jet-assisted-takeoff bottles. Then, suddenly, they were airborne.

Frailey was stripped of his wet flightsuit and wrapped in blankets on the flight home. Upon arrival at Kimpo, the crewmen requested that Frailey remain on the gurney for off-loading. As they moved the stretcher out of the aircraft, one crewman slipped and dropped his end. Frailey was abruptly dumped, *sans* clothes and blanket, onto the hot asphalt. With a crowd gathered to greet him, he stood up and indignantly grabbed for a blanket. To the cheers of his fellow fighter pilots, he said, "Screw it, I'll walk!"

The next day Frailey and Jabara reviewed Jabara's gun camera film, which showed that Jabara had fired nine bursts, hitting Frailey with the last three. Jabara was contrite for the rest of his tour.

Frailey flew nine more combat missions and downed a MiG-15 with the Sabre's six .50-caliber guns. Jabara finished his second Korean combat tour as the jet ace with the second best score: 15 kills. His 16th didn't count—although to Frailey, it counted for plenty. Thus Joe McConnell, with 16 MiGs downed, became the top jet ace of the Korean War.

—John Lowery

Swordplay

In 1951, as a naval aviation cadet in Pensacola, Florida, I learned that the Navy considered us officers first, pilots second, and was going to make sure that we got the requisite officer training before we got into an airplane. There was rifle drill and marching, and, as the Navy had something to do with water, there was swimming. I was not a swimmer by any standard, and had thought of a rifle as something to shoot squirrels with rather than wave around, but things went fairly well—until the first sword drill.

John Paul Jones and other illustrious Navy men no doubt found the sword necessary in their daily work, but it just didn't seem part of the Jet Age. Nevertheless, puzzled cadets were issued swords and shown the proper method of handling a gentleman's weapon.

As soon as the Marine sergeant had separated two duelists in the rear rank, he made his way to my area. "Goodness gracious!" he exclaimed (in harsher words). "You seem to be wearing your doggone scabbard on the wrong doggone side!" I explained that I was left-handed and besides, I really didn't mind the belt buckle being in the back.

"You don't want to look different from everybody else here, do you?" he asked. "It spoils the military effect." Well, no, I didn't, so I spun the belt around, an easy feat since it was about three inches too long.

The sergeant then gave an informative if grammatically incorrect lecture on naval tradition. It seemed that the sword and its proper handling were part of every naval officer's heritage. We were to disregard petty needling from the Air Force about our traditions. A great deal of the grading of our officer-like qualities would hinge on our use of the sword.

I'm not sure exactly how it happened, but as I drew my sword in response to "Present HARMS," there suddenly appeared on the seat of the khaki trousers in front of me a near-perfect Mark of Zorro. On my honor, I explained to the sergeant, I was not skillful enough to do such a thing deliberately. The wounded cadet glared at me over his shoulder as he marched off to the barracks holding his slashed dignity together, and the sergeant was now regarding me with a jaundiced eye.

There were no volunteers to fill the wounded one's space, which suited me just fine: I now had more room to maneuver. Secretly I was somewhat proud, having accomplished what few modern naval officers have done: drawn blood with a sword.

"Now," said the sergeant, keeping an eye in my direction, "we'll try that again. Pre-seeeent HARMS."

There was a decided flinching by certain cowards within a 20-foot radius of me. I held the sword hilt to my face as prescribed and viewed the sergeant around the blade, which probably gave a cross-eyed effect to my rigid eyes-front stare.

WAYNE SHIPP

"Two!" (This meant 'Bring it down,' I think—memory is somewhat dim on this point.) I was just beginning to get into the spirit of naval tradition when the sergeant demonstrated the proper method of returning the sword to the scabbard. He wanted us to jab our swords into the sheaths without obviously looking, and he proceeded to demonstrate.

I admired his nonchalance but felt cold sweat pop out and tried to think of an excuse to avoid such a practice. However, the sergeant was particularly keen to see me complete the maneuver. "Put 'em away!" (or something like that) came the command.

For a test of sheer cold courage, there is nothing like blindly stabbing a razor-sharp length of steel toward your descending colon. I may have allowed too generous a safety factor because I was still stabbing at the air eight inches from my body after the others had replaced their weapons. Soon I realized that it was very quiet and that the attention of the group was directed at me. "You can look now," the sergeant said dryly, and under these conditions I managed to stab only slightly the hand holding the scabbard. Second blood.

"Now," said the sergeant, "we're going to have each of you drill the group."

"I accidentally stabbed my hand," I protested. "Maybe I ought to go have sick bay look at it." I was given a look reserved for those who would shoot themselves in the foot (or stab themselves in the hand) to avoid combat.

My turn came. With trembling knees and blank mind I moved to the front. "Attention," I squeaked. This brought snickers from the ranks, which were silenced by dirty looks from the men with stripes.

"Right Face." Oops, wrong way. "About Face." Now the group was headed away from the wall. I was completely flustered by now, and scratching around in my memory dredged up nothing. A simple command was needed to get the mass moving, but what was it?

The party got restless. Hours ticked by.

This called for desperate measures. Drawing my sword, I brandished it, remembering John Wayne westerns. "At a gallop, forward hooooo!"

When the promotions came, I was appointed Laundry and Morale Officer.

I got my revenge when we started flying. I had 800 hours of civilian flying and was therefore able to skip half of the first three stages of training. After being commissioned in February 1953, I was assigned to a carrier night fighter squadron flying the F4U-5N Corsair. After my cutlery experience, flying off a carrier at night was a walk in the park.

—William K. Kershner

"I dreamed of being a fighter pilot"

Colonel Joseph S. Benham, USAF (ret.)

As a young boy growing up in Illinois, I dreamed of being a fighter pilot. That dream became a reality over 50 years ago when I graduated from the Air Corp cadet class 43K. I was assigned to the Panama-based 51st fighter Squadron, patrolling the pacific approaches to the canal. I will never forget serving my country as a member of the Army Air Corp.

We can help future generations understand aviation's role in America's history. The Smithsonian Institution's National Air and Space Museum, through its unparalleled collection, brings the amazing story of flight to life.

But resources are limited. We must preserve the air and spacecraft on display and restore others that the public can not now see. I have made a provision to provide future support for the National Air and Space Museum. Please join me by mailing the coupon below. Thank you!

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"Stand by to fire the pyro line cutters on my mark: three, two, one!" With that, the explosive devices, all 28 of them, went off, and the giant corset came undone. Inside a vacuum chamber at NASA's Johnson Space Center in Texas, what looked like a three-story-high fabric ice bag began to inflate, still quivering like jelly.

Watching on video and overseeing the test from a nearby control room was project manager Donna Fender, along with assorted engineers, astronauts, and NASA officials. The team whooped as their creation stirred to life, just as it would in space. They were still smiling as the white and yellow TransHab—a new, roomy living space for astronauts—inflated with nitrogen gas to its full 25-foot diameter.

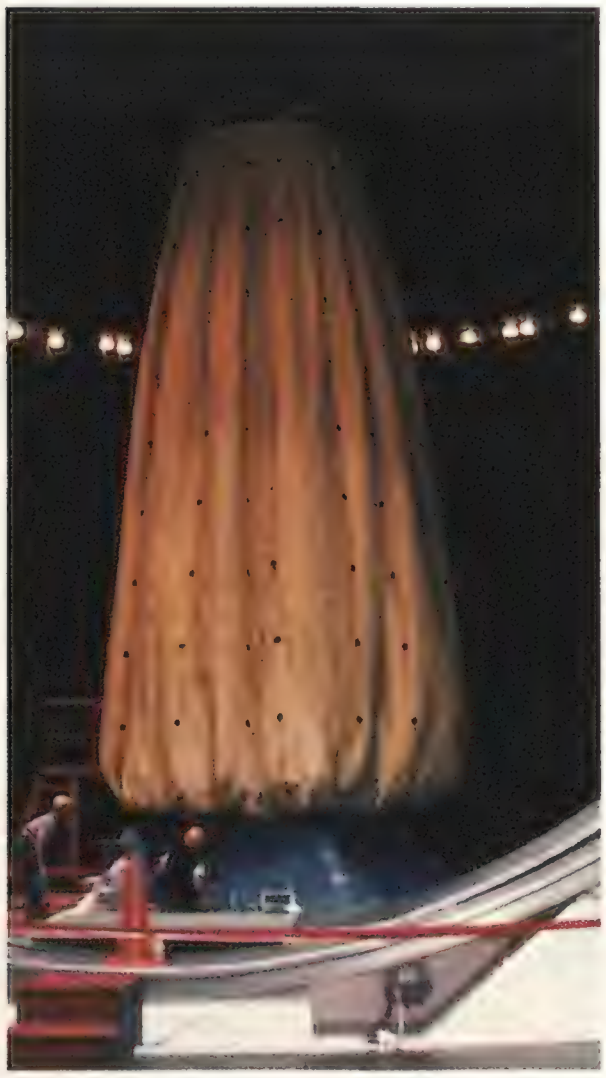
Later, in the early hours of the morning, a few weary die-hards toasted their success with champagne and Italian limoncello at Fender's home. "To an incredible, dedicated team," she said, raising her glass. "What we have just accomplished will enable people to further their exploration past Earth orbit."

The test, conducted four days before last Christmas, was the last major development hurdle for TransHab, a proposed Mars habitat that NASA is also considering as a replacement for the aluminum "habitation module" the agency plans to attach to the international space station in 2004. Aside from a few cords that got hung up in eyelets, the packaging and deployment test went perfectly. "It was, I think, a very proud moment," says Fender. "We have worked so incredibly hard for so long."

TransHab is essentially a huge, pop-proof balloon, although the terms "balloon" and "blow up" are strictly verboten around the project office ("inflate" is preferred). Made of tough fabric wrapped around a rigid carbon-fiber core, it would be folded like an umbrella for launch, then filled with air once attached to the space station. Besides offering three times more living space than the one-room aluminum cylinder NASA asked Boeing to build, TransHab would feel more like a real home: three floors, six tiny bedrooms on the second floor, a third-floor gym, cathedral ceiling, dining room and kitchenette, two windows, and lots of stowage space, enough to double the station's overall storage capacity. Attached to the cylindrical core would be a pull-out table for 12 and floor struts that could be extended and covered with fabric: Presto, instant carpet.

When astronauts see the full-size mockup at Johnson, says Fender, "they just go 'Wow, I *want* this!' "

TransHab fills with air inside a test chamber at the Johnson Space Center. This low-pressure checkout shows the module's main advantage: It folds up for easy storage in the shuttle.



NASA (4)

Launch. Inflate.

by Marcia Dunn

The selling points are more than cosmetic. TransHab offers better protection against radiation and micrometeoroid impacts than does the aluminum competition. Its foot-thick shell of foam and fabric, 16 layers in all, has stood up to pellets fired from guns in the lab to simulate meteoroids and other threatening objects zipping through space. A two-inch-thick wall surrounding the bedrooms—actually wedge-shaped cubicles in the cylindrical core—would be filled with water, an effective shield against noise and radiation. (A Mars-bound crew could also use it for drinking, replenishing it with water produced by electrical fuel cells.) TransHab's designers are also considering adding an attic-like fourth floor where a human-size centrifuge could be installed. Exercising astronauts would be exposed to artificial gravity as they cycle inside their inflatable home.

With all these fancy options and obvious advantages, why haven't space inflatables caught on—especially considering that NASA has been studying them since 1960? One of the biggest obstacles has been psychological. Most people flat-out don't believe it's possible for fabric to be as strong and durable as metal, says NASA's Kriss Kennedy, a space architect who helped create TransHab and coined the name, a shortened version of "transit habitat." Astronauts were among the early skeptics. "When people hear that, they raise their eyebrows. I did too, initially," says Laurel Clark, an astronaut and Navy doctor who has advised the project.

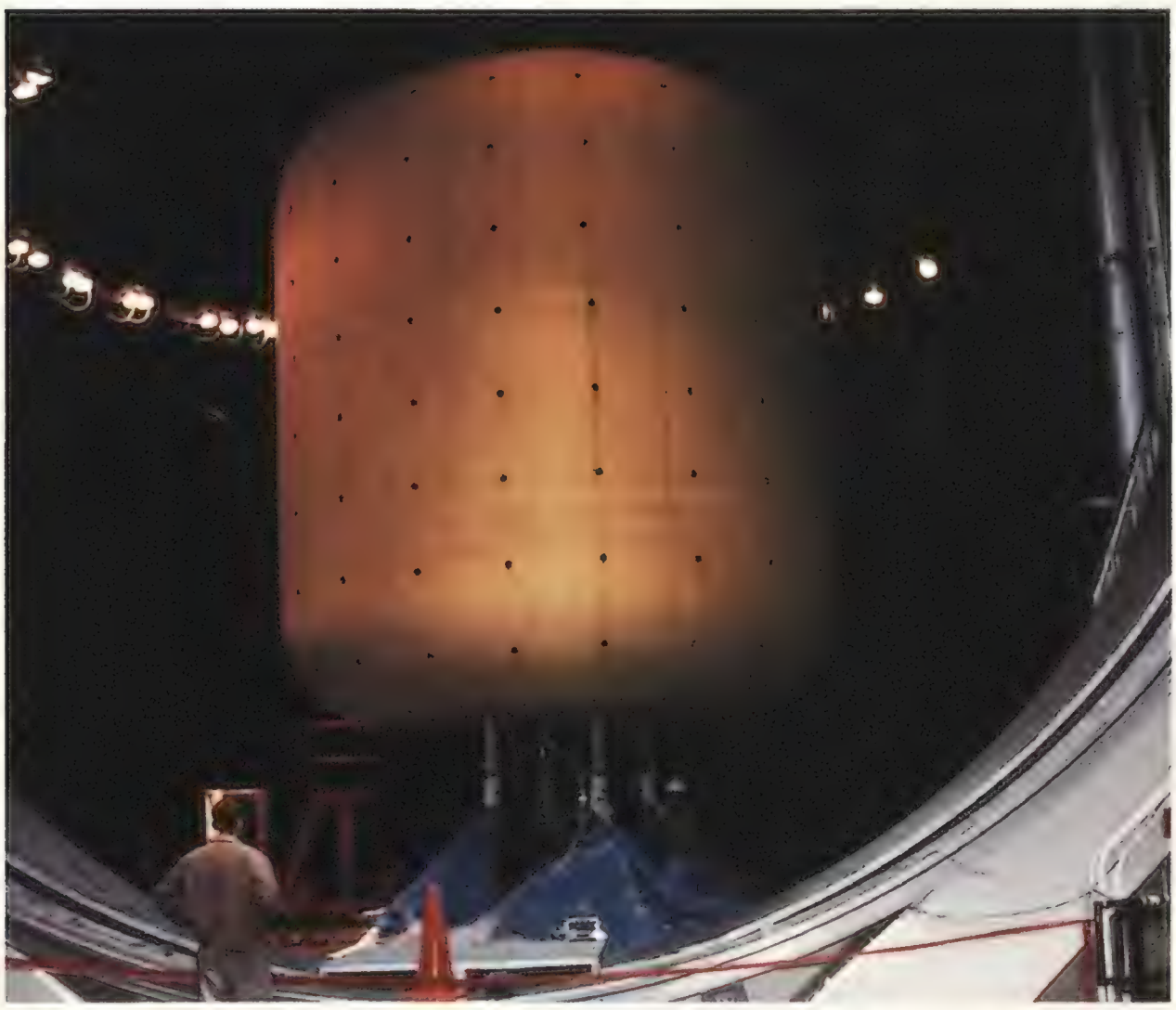
Because Kennedy knows the first worry on everyone's mind, when he gives public talks on TransHab, he pulls out a balloon and pops it. "I get their attention," he says, chuckling. "But my point is that *this* is a balloon, and an inflatable structure is *not* a balloon. It's a tension-membraned structure—very rigid once inflated, very hard. It's as hard as this," he says, knocking on a wooden table.

Fender compares TransHab to a pressurized spacesuit, albeit a really big one. Horacio de la Fuente, the project's deputy manager for technical development and manufacturing, prefers a football analogy. Both a football and TransHab have bladder systems to hold air, he notes. TransHab, in fact, has three thin-film bladders (for redundancy) covered by alternating layers of ceramic fabric, polyurethane foam, and Kevlar, a super-tough material used in bullet-proof vests.

The mustard-colored Kevlar webbing constitutes the so-called restraint layer, which holds pressure. It's woven like a rug—by hand, no less—to reduce the number of seams, thereby adding strength. Thin sheets of ceramic fabric called Nextel separated by three-inch layers of foam protect against micrometeoroids hitting TransHab at speeds of several miles per second. The foam is for spacing and for greater flexibility in folding.

To test the module's spaceworthiness, the TransHab team shot marble-size aluminum balls into the multi-layer shell at velocities up to 16,000 mph. Each time, the Nextel pulverized the balls before they reached the air-containing bladders. When the same type of balls were fired at aluminum plates an inch and a half thick, they left craters the size of hockey pucks and ripped chunks off the back of the plates. Even reinforced aluminum of the type intended for use on the space station would be pierced, says de la Fuente. In a collision like the one that ruptured Russia's Mir space station two years ago, he says, "I would feel much safer" inside TransHab.

Tests like these have helped change the skeptics' attitudes. "This is finally getting to the point where people are waking up and taking notes and saying 'Wow. Okay. This could be doable,' " says Kennedy. In fact, according to George Parma, TransHab's deputy manager for project planning and integration, the word around NASA is "If we had thought of this before we started



Insert Crew.

Transhab's inventors hope to build the world's first inflatable spacecraft.

building the international space station, we would have made the whole thing out of inflatable modules."

It's too late now to wrap a foot-thick TransHab shell around the metal modules already under construction. The cylinders barely fit into the shuttle cargo bay as it is; the Unity "node" carried aboard the shuttle *Endeavour* in December had a mere inch of clearance on either side. But station managers are considering wrapping TransHab meteoroid protection around parts of the modules after they're in orbit.

Suddenly it's fashionable to talk about space stations covered with fabric.

NASA's first inflatable space habitat, or its first on paper, was a doughnut-shaped space station designed at the Langley Research Center in Virginia around 1960—the same year the Mylar-coated Echo 1 balloon was launched into orbit to bounce radio signals back to Earth. The 24-foot-diameter space station would have rotated slowly to create artificial gravity, recalls Clarence Keffer, a retired Langley designer who worked on the project.

That concept was followed in 1965 by inflatable moon habitats and in 1967 by another air-filled space station module so big it was nicknamed Moby Dick. Next came an airlock, a tunnel, and a space shuttle lifeboat. None of these inflatables made it to space, but engineers got as far as building mockups for at least some of them. The moon shelter's fabric-and-foil walls were two inches thick, including the foam. While the structure held up well in pressure tests, the sandwich-type walls could have been pierced easily by a micrometeoroid or piece of orbital debris. Space junk wasn't much of a worry in the 1960s, however. A couple of years ago, Kennedy, the TransHab architect, had Langley search everywhere for Moby Dick and the moon houses, but they couldn't be found; evidently they'd been tossed out.

Keffer and the handful of Langley engineers who worked with him hoped the idea of inflatable spacecraft would catch on. After all, he says, "nobody really cast doubt on it." But nobody championed it either, and by the mid-1970s inflatable development had come to a halt at NASA. Interest revived briefly in the late 1980s when the Bush administration talked about charting a course to the moon and Mars, but the technology wasn't mature enough. A prototype inflatable sphere developed in 1989, for instance, kept tearing along the seams. Concepts for inflatable moon lodges and construction shacks, which would have been covered with a layer of lunar soil to protect against radiation, never made it into mainstream NASA thinking.

Lowell Wood, a physicist at California's Lawrence Livermore National Laboratory and one of the principal architects of the Reagan-era Strategic Defense Initiative (SDI) missile defense concept, also began pushing inflatables in the late 1980s as a way for his lab to get in on Bush's proposed Space Exploration Initiative. Wood and his colleagues had at least a passing familiarity with inflatable technology, and it wasn't much of a stretch to suggest air-filled moon and Mars bases, transporters, and fuel tanks made of expanding fabric walls. "It's a very, very obvious thing," Wood says today. "We don't claim there's any novelty at all to what we did." The Livermore group even did some engineering development work using small-scale structures wrapped in Kevlar.

But the Space Exploration Initiative went nowhere, Livermore went back to defense and energy-related work, and Wood's short flirtation with the civilian space program came to an end. Now he's pleased that inflatable spacecraft finally seem to be taking off at NASA. "It's always regrettable that things don't happen faster than they do," he says. "But it was only a decade. It might have been two or three."

Terrestrial uses of inflatable structures have made "a huge comeback," according to Kennedy, due largely to advances in tough fabrics made with fewer and stronger seams. The Army, for example, is developing rapid-deploy medical tents and aircraft hangars that could be packaged and repackaged many times. These would have to be airtight in the event of chemical warfare, but wouldn't have to withstand the extreme conditions of space. Despite their different needs, NASA and the Army keep an eye on each other's work and frequently trade technical information on inflatables.

TransHab was conceived in early 1997 by a Johnson Space Center engineering team under the direction of William Schneider, who had worked on micrometeoroid protection for the space shuttle. Its original purpose was to provide living space for astronauts traveling to and from Mars. It seemed

Donna Fender leads the team of young engineers hoping to build a flight version of their innovative space habitat, which appears in the background without its protective shell.

DAVID NANCE

3 lvls, 6 bdrms, stunning vus

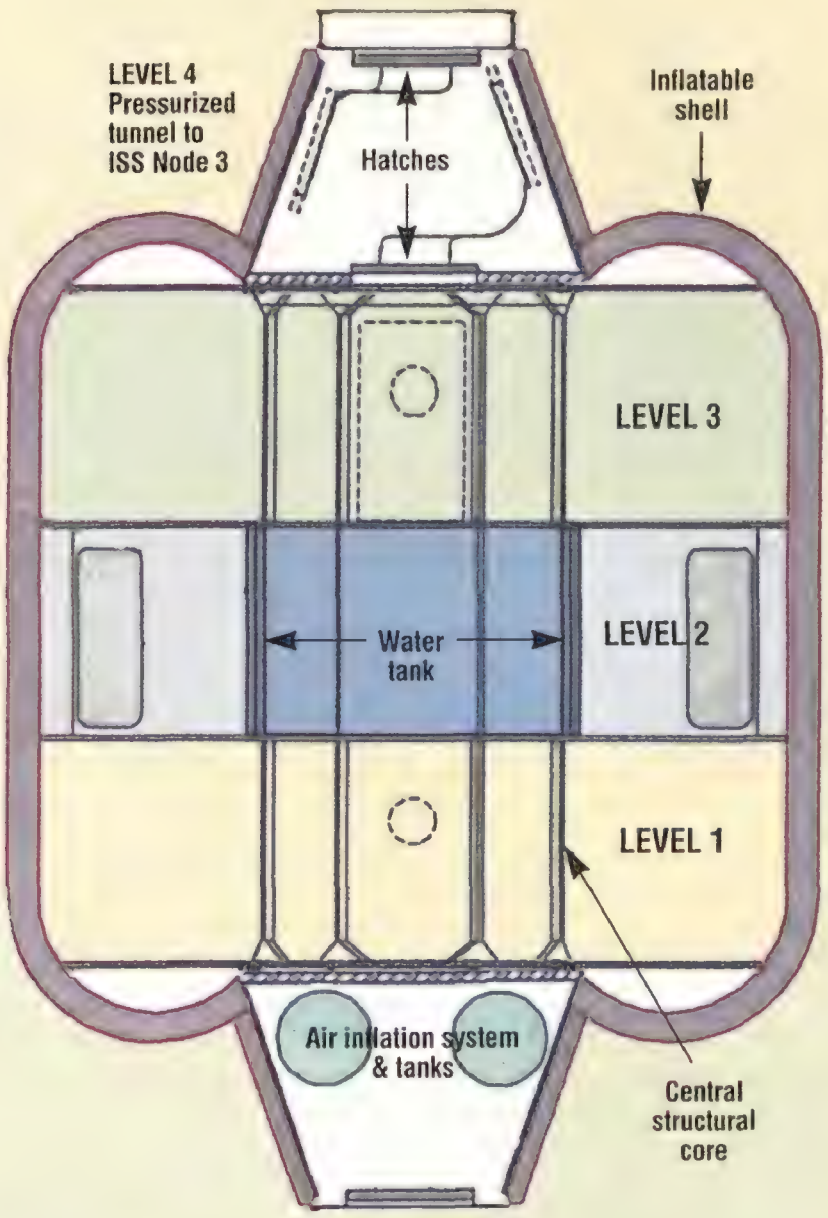
From outside, TransHab will look like just another module plugged into the Tinkertoy structure of the space station. But to the weightless astronauts inside, it will feel more like a three-level apartment with separate floors for exercising, sleeping, and eating and socializing.

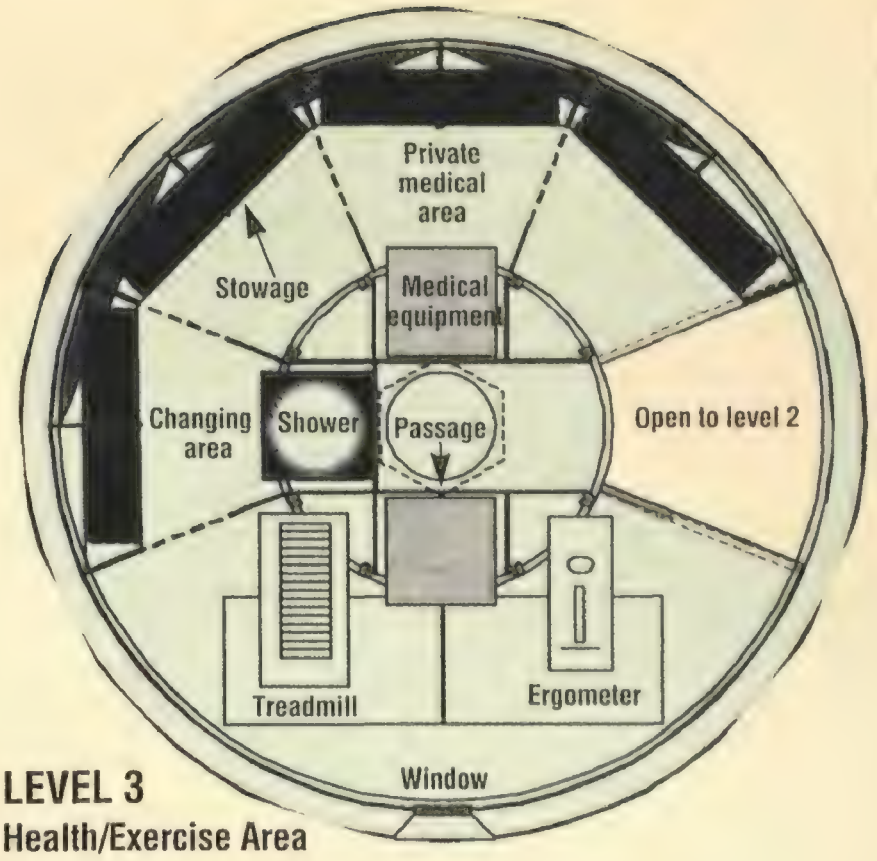
The floors themselves will be made of a flame-retardant fabric that absorbs sound. Walls will be moveable partitions similar to those in office cubicles, and can be used to close off areas for changing or private medical consultation. Stowage bins (dark rectangular boxes) will line the circumference of the module on the first and third floors, with additional storage space inside the honeycomb-like grid of the central core. Each bedroom has a volume of about 80 cubic feet and will be furnished with frame-and-fabric work/entertainment stations delivered to the space station and installed after the module is inflated.

At the center of the core is a 42-inch-diameter passageway the astronauts will use to float from one floor to another. They also will be able to float straight "up" from the kitchen table to reach the second floor. From there, they can either continue up to the third floor through a wedge-shaped opening or pass through either of two doors to enter the module's mechanical room.

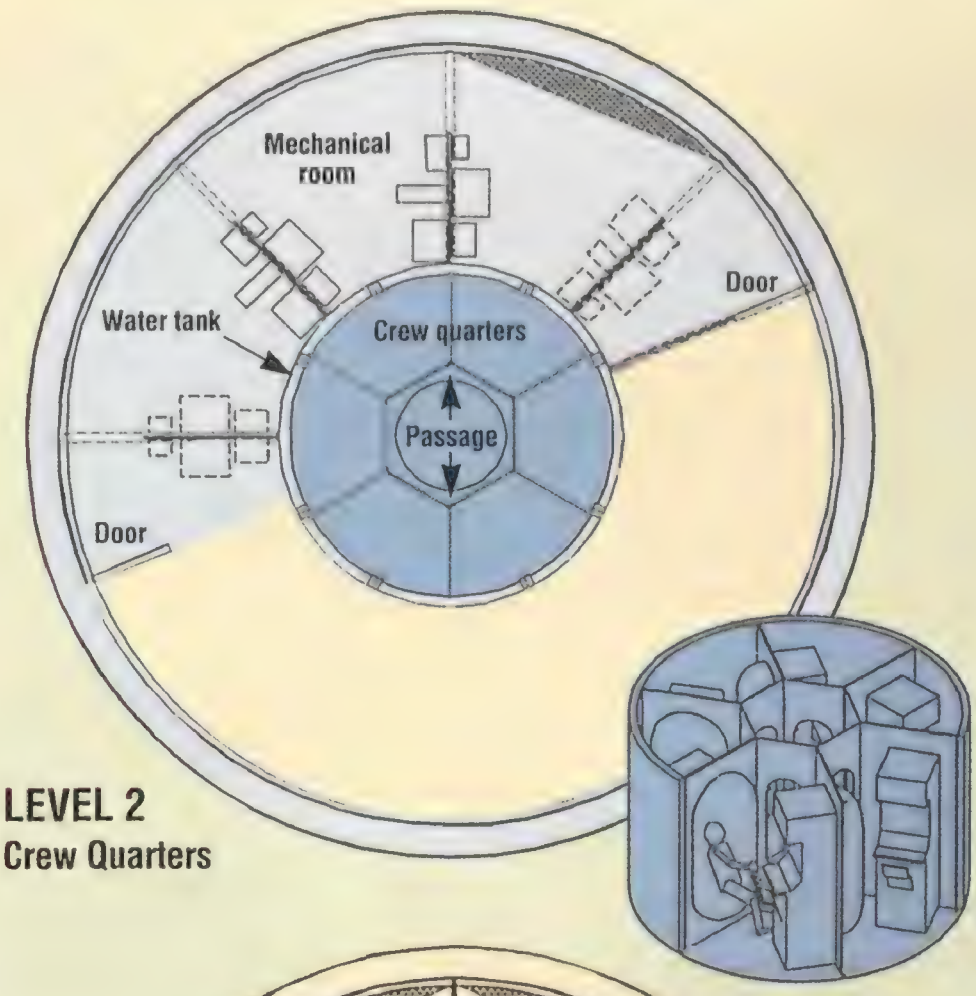
Americans who have spent time on the Russian Mir space station say the downstairs galley is likely to be a popular gathering place, as astronauts crowd around the 20-inch-diameter window facing "down" toward Earth.

The pressurized tunnel above the third floor connects TransHab to the rest of the station. What appears to be another tunnel at the opposite end is actually a closed-off unpressurized space containing the module's inflation system.

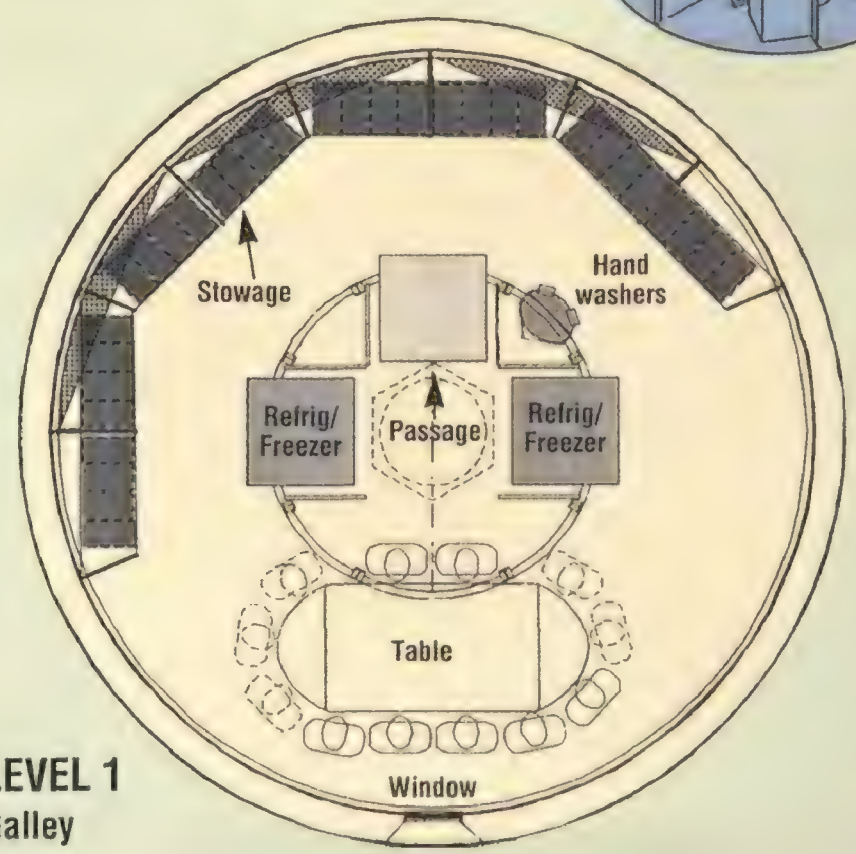




LEVEL 3
Health/Exercise Area



LEVEL 2
Crew Quarters



LEVEL 1
Galley

ILLUSTRATIONS: NASA

NASA (2)

A scaled-down model of the TransHab passed its trial-by-water last year in Johnson's 40-foot-deep Neutral Buoyancy Laboratory. It never leaked, even at four times the air pressure planned for the space station.

ideal: spacious, lightweight, and no more expensive than a much smaller metal can. Similar structures sent ahead to Mars could provide living quarters for an expedition that would land later.

Until then, micrometeoroid protection had been the weak link, but Schneider's group solved that problem by coming up with the Nextel-and-foam idea. Now the senior engineer at Johnson, Schneider generally gets credit as the "Father of TransHab."

When advocates in the engineering office and in NASA's human exploration office took the concept to space station managers, the station people were intrigued. Fender, who had joined NASA

in 1988 right out of college and had risen to become a deputy branch chief in the engineering directorate, was put in charge of a small team and asked to determine if the inflatable habitat could be adapted for the station. They were given a year and $2 million to find out.

If the answer was yes, it would not only improve the station, it would give the Mars program a technological leg up.

Talk to the members of the TransHab team, all of them young and enthusiastic, and you'll hear what else inflatables have to offer. Think entertainment and tourism, they say. The movie industry might go for inflatable studios in orbit. Or, says deputy manager Parma, "Rent it out as space for people to go on vacation and play in zero-gravity, bounce around like on Skylab.

"This is definitely the way of the future," he adds. He envisions "a blooming industry" where "we'll start building these things commercially just like they now build Delta rockets." NASA has applied for a patent for TransHab in case the customers come flocking.

For now, though, the team is concentrating on getting the habitat module ready for the space station, should NASA give the go-ahead. The test article assembled late last year in the Apollo-era vacuum chamber in Building 32 at Johnson was slightly smaller than the version that would go into space. The flight model would be 27 feet in diameter and 36 feet high, including the tunnels. The module would grow another three feet in height if the human centrifuge is approved. The TransHab would weigh about 26,000 pounds empty and 35,000 pounds outfitted with water and air. Boeing's conventional habitation module would be 14.5 feet in diameter and 28 feet long, and would weigh about 32,000 pounds—the same dimensions as the U.S. laboratory module, which Boeing also is building.

The pre-Christmas vacuum chamber test proved that TransHab could be bundled to fit in the shuttle cargo bay, and that it could unfold and inflate after being attached to the station. The space version would be launched with its own supply of compressed air; nitrogen gas was used in the test because it was readily available. The test article was inflated to the space station pres-

DAVID NANCE

TransHab team members Jasen Raboin, Kriss Kennedy, and Constance Adams (left to right) confer inside a mockup of the module's interior.

sure of 14.7 pounds per square inch, which matches the atmospheric pressure at sea level on Earth. It took three and a half hours to pressurize, and the pressure was held for an hour.

Fender's team has taken great pains to overcome TransHab's "balloon" stigma. In September, a squat mockup shaped like a fat tire was submerged in a 40-foot-deep pool at Johnson known as the Neutral Buoyancy Laboratory, where it was overfilled with air and subjected to four times the maximum operating pressure of the space station. Remarkably, it didn't pop a single stitch.

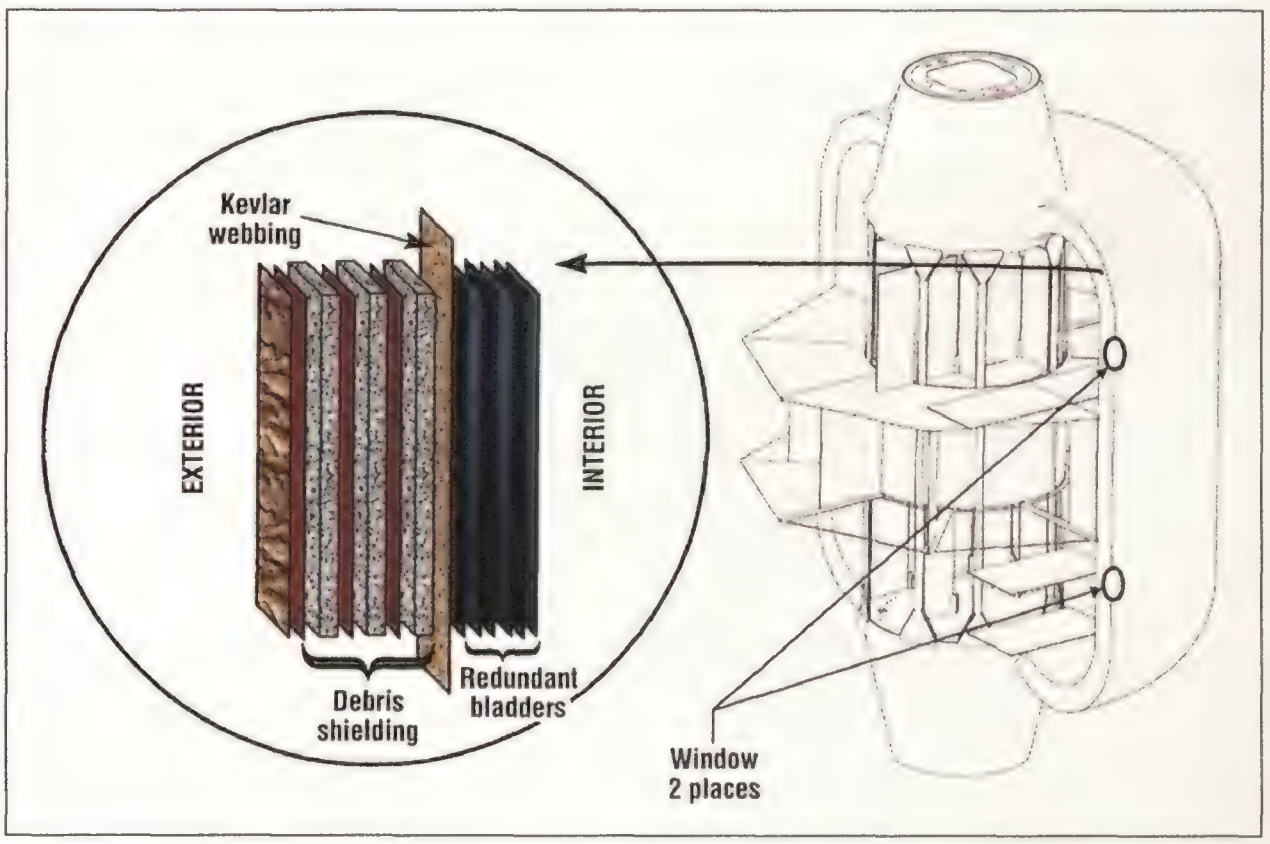
For Fender and her team, that was The Test. "People go 'Yeah, so what?,' " but holding four times the station's normal pressure for 10 minutes is no ordinary achievement, she says. "To tell you the difference, the station modules are designed to two times. Shuttle was designed to one and a half. There's never been a module designed and tested to four times. Never. Not even a metal can. So this is a big, big, big deal."

Compared to that ordeal, the deployment test in the vacuum chamber would be a cinch, the team figured. They were right. The hardest part, says Fender, was dealing with gravity. The team had to rig a series of marionette-style cables, rollers, and levers to support the weight of 21 panels of Nextel meteoroid protection that were lifted by crane and attached to the outside of TransHab. Each strip weighed about 350 pounds, so the total load on the rig approached four tons.

A couple of weeks before the test, Fender proudly showed off the weight-bearing assembly from a fifth-story perch inside the vacuum chamber. "Hey guys!" she called down to two technicians lying on top of the module as they waited to install more panels. "Don't you poke a hole in my TransHab," she shouted, then laughed. At that moment, a crew of shuttle astronauts 250 miles overhead were pulling off NASA's first space station assembly mission—a reminder, Fender said, that "this is really happening."

The test itself had only one minor glitch. As the structure was expanding, some of the restraining cords got hung up in eyelets, which pulled away the Nextel paneling in a couple of places—a minor problem that will be easy to correct, says Parma. The only things missing from the test version of TransHab were its thermal insulating blankets. Those will be added for another vacuum chamber checkout this fall, in which an improved test article will be exposed to the wide range of temperatures experienced in orbit.

Space station program manager Randy Brinkley wanted the results of the vacuum chamber test in hand before deciding between TransHab and its metal-can competition. At first glance, TransHab appears to be one of those rare projects in which everything turns out positive and there are no negatives. Fender estimates it will cost somewhere in the neighborhood of $200 million. In return, astronauts would get "the very best habitation module we have," she says. By comparison, the Boeing-built Unity node launched last year cost $300 million, and the Russian-built Zarya power and propulsion module came in at $240 million.



The secret of TransHab's strength is in its tough hide. Three air-filled bladders are backed by a web-like "restraint layer" that holds in pressure and a multilayer foam-fabric debris shield.

So why doesn't NASA just commit to the inflatable option?

"Clearly we would prefer to go with the TransHab, all things being equal," Brinkley says as he mulls the two choices. But Boeing, the prime contractor for the space station, may not give up easily on its aluminum module. According to one knowledgeable NASA official who asked not to be identified, every time the TransHab project office comes up with a cost estimate the company matches it; now Boeing's price for the aluminum module is also hovering around $200 million. "I'm not sure how real those figures are," the official confides. "When we got into this, it wasn't anything like that. Now when we come in with our cost, [Boeing] seems to track it pretty quick."

Kari Allen, a Boeing spokesperson in Houston, says it's not that simple. When NASA commissioned the TransHab study, it ordered Boeing to stop work on the hab module, which remains an aluminum shell. The new price, she says, reflects only what it would take to complete the job. She doesn't say what that price is, but guesses it would be less than the cost of building TransHab from scratch.

For the astronauts who have seen the roomy inflatable module, there's no contest between it and the standard metal can. They want as much volume in orbit as they can get. So do Russian cosmonauts. "Additional space is a very valuable thing in space station," says Sergei Krikalev, a Mir veteran who's also flown on the shuttle. He will return to orbit next year as the international station's first full-time flight engineer. "If TransHab will come to the station, it will be pleasant experience for all astronauts," says Krikalev.

Architect Kennedy puts it this way: "I like to think we're putting the 'living' back in 'living and working in space.' " The bedrooms in TransHab would be about twice the size of a phone booth, more than 25 percent bigger than those in the Boeing habitation module. Each would be outfitted with a desk and a computer. Laurel Clark, the doctor/astronaut, especially likes the fact that the bedrooms could be used as fallout shelters in the event of a solar flare, thanks to the water-filled wall surrounding the core. The bathroom would be next door in Node 3, although a wash-up area would be located on TransHab's third floor next to the treadmill and cycling machine.

Which brings up another bonus: The exercise equipment could stay up all the time in TransHab, whereas in the Boeing module it would have to be folded away when not in use. Also, in the smaller module the gym and the dining area are right next to each other. And in space, explains astronaut-physicist and TransHab advisor Jeff Wisoff, "Sweat floats."

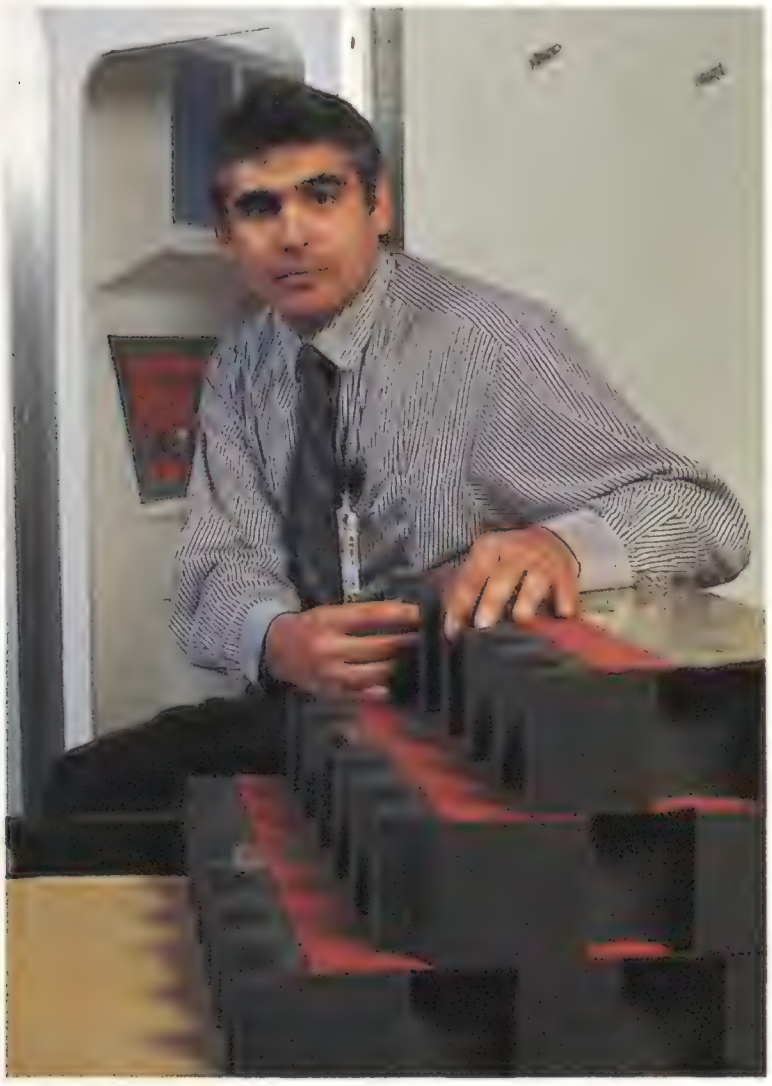
The fact that TransHab has six bedrooms and NASA planners frequently talk about housing seven people on the station could pose a problem. "I'm sure they'll ask us 'Stick seven in there,' " says Fender, sounding like a parent with one too many kids for the minivan. She could accommodate another person, she says, as long as it's not in the water-enclosed core. At this point, she'd be loath to do a major redesign. "The whole point of doing TransHab is that it's one module that can do multiple applications," she says. "You can go on space station with it. You can go to Mars with it. You can go to the moon. I want one design to fit everything, so I'm trying not to perturb the structure."

Astronauts like Clark and Wisoff had considerable influence on the interior design. An early plan divided the volume in half lengthwise, like a submarine sandwich. But astronauts and engineers eventually agreed it would be more homey to divide the structure vertically into three "floors." Part of the second floor over the dining area was cut away to give crew members the sense of open space, like a cathedral ceiling. Astronauts also suggested the window locations: one in the first-floor dining area and the other in the third-floor gym.

The strongest recommendation from the seven Americans who lived on Mir was to have a large table and meeting area where up to a dozen people could gather. This would be useful during changeover periods when two full crews are on the station. In the typical aluminum module, such an arrangement would be impossible, and you'd end up with senior crew members at the main table and junior members crammed in a corner, worries Clark. "You could get into a divisive atmosphere," she says. "You want to find an atmosphere where it puts everyone on an equal footing."

Although the emphasis for now is on the basic layout, the TransHab team is collaborating with architecture students at Yale and the Rhode Island School of Design to come up with a color and decorating scheme. One thing's for certain: Somebody will end up unhappy. After much debate, the interior of the station's Unity module was painted mostly white, with some parts salmon. "The decision was made years ago," Clark says, "and a lot of people didn't like it. I think some people feel no color is better than a color they don't like." The interior of the Russian-built Zarya ended

Deputy project manager Horacio de la Fuente is counting on layers of Kevlar (yellow), foam (gray), and Nextel (red) to keep air in and meteoroids out.



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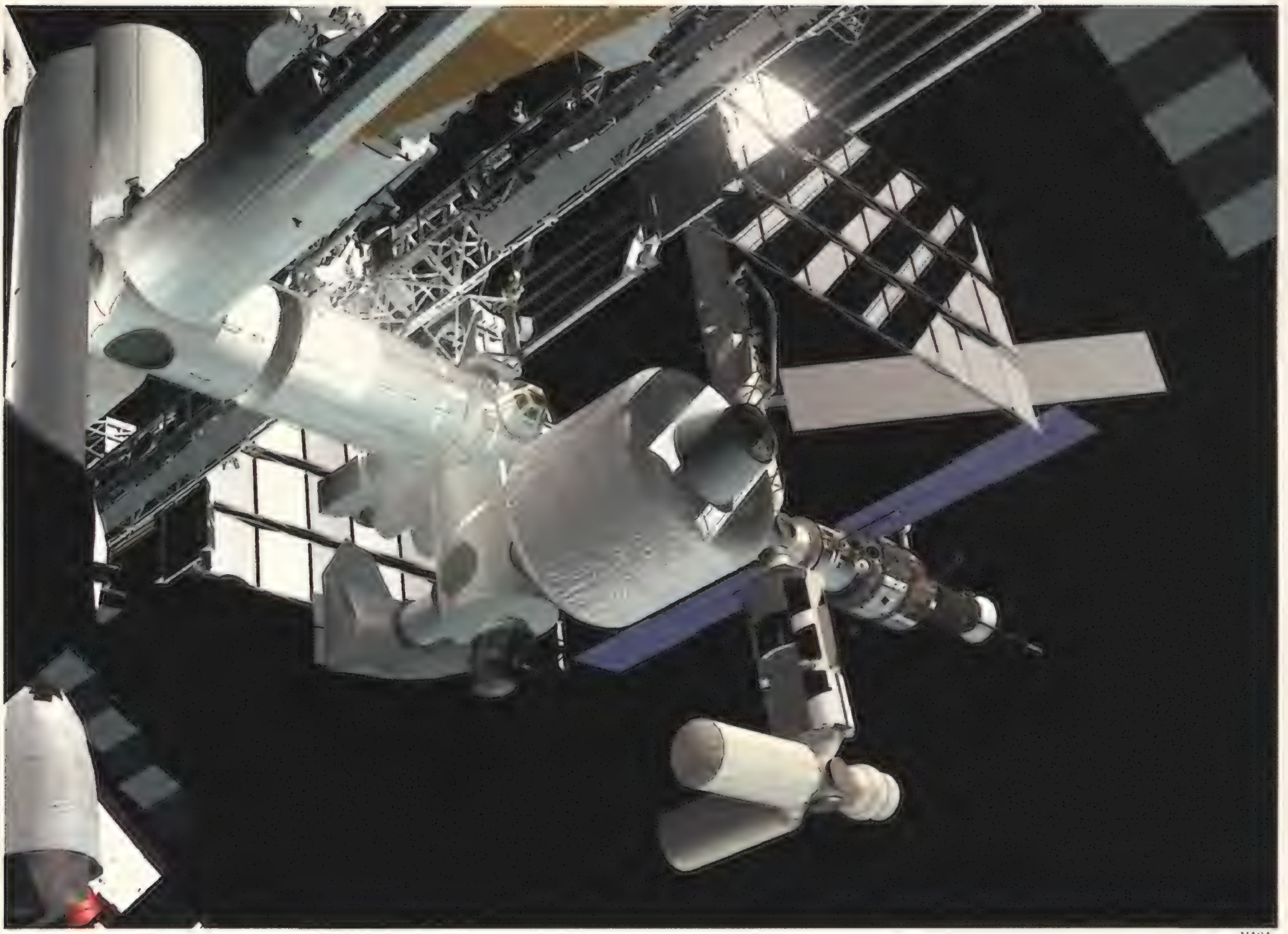


NASA

If it flies, the wide-body TransHab (center) will attach horizontally to the station at one of its connecting nodes.

up mint green, dull cream, dirty white, or a blend of all three, depending on the lighting.

What about wallpapered panels with a floral design on one side and something wild and spacey on the other that could be flipped to suit the taste of whoever is there? Just a joke, says Fender. But you get the sense she's not ruling it out entirely.

Skylab astronaut Bill Pogue, who lived in space for three months in the early 1970s and is now an aerospace consultant, sees TransHab as "a poor man's way of getting more volume." Inflatable spacecraft may turn out to be "a perfect bust," he says. "But hey, give it a shot." The reason for going into space, says Pogue, is to try new ideas. Wisoff, who was the astronaut office's point man for TransHab until he was assigned to a station construction mission that will fly later this year, agrees with Pogue. He says a big reason the astronauts are so keen on TransHab, apart from the extra volume, is that it's pioneering technology, and a bridge to future exploration. "You're not going to find anybody in our office who wouldn't support going back to the moon or on to Mars," he says.

NASA Administrator Daniel Goldin also loves TransHab, predicting that it will be "one of the major breakthroughs in the space program, the kind of innovation that comes around every 10 or 20 years." But even the normally audacious Goldin is taking things slowly. "Before we want to commit to TransHab for station, we want to make sure that everything is as close to understandable as we could get it," he says. Goldin hints that one option, at least for the near term, would be to pursue parallel development of both TransHab and the Boeing module, to "make sure we know where we are."

The space station office is under tremendous pressure to succeed, notes Kennedy, and that could be the real reason NASA managers seem indecisive about TransHab. A decision on whether it would be substituted for Boeing's habitation module was supposed to come in October 1998, then December, then January, then March. "They think of us as another added risk," says Kennedy. "Whether that's true or not, that's the perception."

If TransHab gets picked, current plans call for NASA engineers to build most of the module in-house. Construction would likely start at Johnson in 2001, with launch three years later. The Italian space agency and the Rome-based Alenia Aerospazio almost certainly would provide the carbon-fiber core and the tunnels on either end. NASA would install the life support systems and avionics in the core and handle the overall assembly job.

As of early spring, Donna Fender and her TransHab team were still waiting for NASA's decision. In the meantime they had plenty of other worries, like how to add that fourth-floor attic.

One Helluva Roar

by Nan K. Chase

Over their heads: In 1951, long before today's strict safety regulations, the Skyblazers gave spectators in French Morocco an up-close and ear-piercing performance.

Before the Thunderbirds
took over, it was up to
show-offs like the Acrojets,
Red Devils, and Skyblazers
to prove that nothing could
stop the U.S. Air Force.

COURTESY "BUCK" AND "BILL" PATTILLO

USAF

Walt Williams of the Air National Guard Minute Men greeted enthusiastic fans in Panama. The Red Devils and their F-51s lasted less than a year (below).

The lasting image of the Thunderbirds, the official aerobatic demonstration team of the U.S. Air Force, is that of airplanes hand-painted to perfection and buffed to a high sheen, and their pilots turned out in tailored flightsuits—movements carefully choreographed with ground crews, carriage and demeanor almost robotic.

Nearly forgotten on the road to razor-sharp showmanship, a handful of aerobatic teams streaked over Europe, North Africa, and the United States after the Air Force was formally created as a separate service in 1947 and before the Thunderbirds were commissioned in 1953. The Acrojets, Red Devils, Skyblazers, Sabre Knights, and even, briefly, the Jesters all had their day in the sun.

Those teams differed on the ground from today's Thunderbirds—one group occasionally wore ape masks—and their carriage was decidedly unstuffy. "We prided ourselves on informality, and felt that our direct approach to our audiences was one of our strong points," says Jacksel M. Broughton, a former member of the Europe-based Skyblazers and a former Thunderbirds commander. But despite occasional playfulness, the teams made serious contributions to Air Force public relations, to the image of NATO among European citizens, and to the understanding of jet aircraft performance.

Even if officially sanctioned—although some of them barely so—many of the early aerobatic teams worked without the designated aircraft and support crew that today's Thunderbirds enjoy. The pilots honed their routines in the evenings after their normal duty day, and they performed at weekend airshows for no extra pay and, commonly, received no expense money.

Retired Major General Jones "Jonesy" Bolt, who was involved in the early test program for the Lockheed P-80 Shooting Star (redesignated F-80 after 1948), was on the forefront of a new age. The war was over, but times were tough. "When we first started, the Air Force was so poor we didn't have any spare equipment, so we had to scrounge whatever we needed," Bolt says. In order to get spare parts he would sometimes cannibalize aircraft, installing in a P-80 a faulty component or a broken or near-broken part that wasn't absolutely necessary for flying. Then he would fly to the Lockheed factory in Burbank, California, and have technicians replace the broken part with a new one. The practice even extended to large components, like tail pipes and elevators.

"We had a tough time with the tail pipes," says Bolt. "They had a habit of cracking, and that was dangerous. You could weld it up to a point, then the weld would crack and it would have to be changed. I'd go to the depot and put a bad one on that was O.K. for a couple hours and write the depot at the factory to get it replaced." The Air Force quietly reprimanded Bolt for his creative supply management.

But despite the hard times, the flying was great. Some of the young fighter pilots were getting restless, popping rivets and stressing their new planes as they twisted and turned in the clear skies over Williams Air Force Base in Arizona, often to the discomfort of wing commander Brigadier General Thomas C. Darcy. The hotdogging was getting worrisome. "It had to be controlled, and General Darcy put a stop to this," Bolt recalls. "[He] said to the training group commander to pick a few guys to do these things instead of going wild, so we didn't break airplanes and make monkeys out of ourselves. He said, 'Let's get professional.' " And thus the first officially sanctioned Air Force jet demonstration team, the Acrojets, was created.

Bolt replaced early team member Benjamin "Pierre" Yeargin and joined Howard "Swede" Jensen, Michael Smolen, Walter "Lefty" Selenger, and Robert C. "Tommy" Tomlinson as they perfected in 1948 what would become

COURTESY COLONEL DONALD GRAVENSTEIN

a 20-minute routine: Cuban Eights, Split-S's, Immelmanns, and Clover Leafs, all in a four-ship diamond formation.

"We didn't push it," says Bolt, in a rich South Carolina accent. "We were all very conscious that if we had an accident it would put an end to a thing that even then we felt was important. All of us were kids but we felt very strongly that the general public needed to know what we did in training fight-

COURTESY JONES BOLT (2)

In thrust we trust? The Acrojets were the first aerobatic team to fly the first operational U.S. jet aircraft, the Lockheed P-80 (F-80 after 1948) Shooting Star. Without worrying about whirling props, pilots could get their aircraft closer than before (above), but early jets were prone to flameouts. Right, standing, from left: Howard "Swede" Jensen, Walter "Lefty" Selenger, Robert "Tommy" Tomlinson; kneeling: Mike Smolen, Jones "Jonesy" Bolt.

would be rather spectacular, had to be the climax of the show." Until Republic Aviation, manufacturer of the F-84s used by later teams, developed a system to pump hydraulic fluid into the tailpipes, aircraft left no smoke trails. In the bomb burst, pilots flew as far as 10 miles apart without being able to see each other, but had a preassigned order—lowest to highest—to make the convergence safe and could keep track of each other through radio transmissions.

The group answered dozens of civilian and military invitations from across the United States. In March 1949 they became more than a base-sponsored activity and received recognition as an official team from Air Force headquarters, thanks largely to the support of Darcy's successor, Robert L. Scott Jr. (author of *God Is My Co-Pilot* and an effective publicity man). The Acrojets

er pilots, to show the public that we weren't a bunch of idiots trying to commit suicide."

Still, they urged their aircraft to the limit in those early shows, which were unencumbered by regulations and safety officers. The pilots came down as low as 50 feet above the ground, and began their program with a roar above the spectators' heads.

The Acrojets also developed a version of the now famous bomb-burst maneuver, which is still the climax of most Thunderbirds shows. The spectacular feat, with four aircraft rising vertically and breaking off on the four compass points, had a pretty inauspicious beginning. "We were all at my house one evening for dinner, all four of us, and we said we needed a way to end this show," Bolt says. "Swede got out his pencil on my wife's only linen tablecloth—she got mad as fire—and drew what is now the bomb-burst. We decided that something like this, which were getting more exposure, and even enjoyed the services of a Hollywood costume designer, who dressed them in black and red flightsuits. They also added an announcer to their performances because, Bolt says, "Nobody knew what was going on unless somebody told them."

USAF

The Skyblazers flew a variety of fighters, including the elegant F-86 Sabre (left, over France). While flying Republic F-84Es, the team performed for NATO Commander General Dwight D. Eisenhower in 1951 above their home airfield in Fürstenfeldbruck, Germany (below).

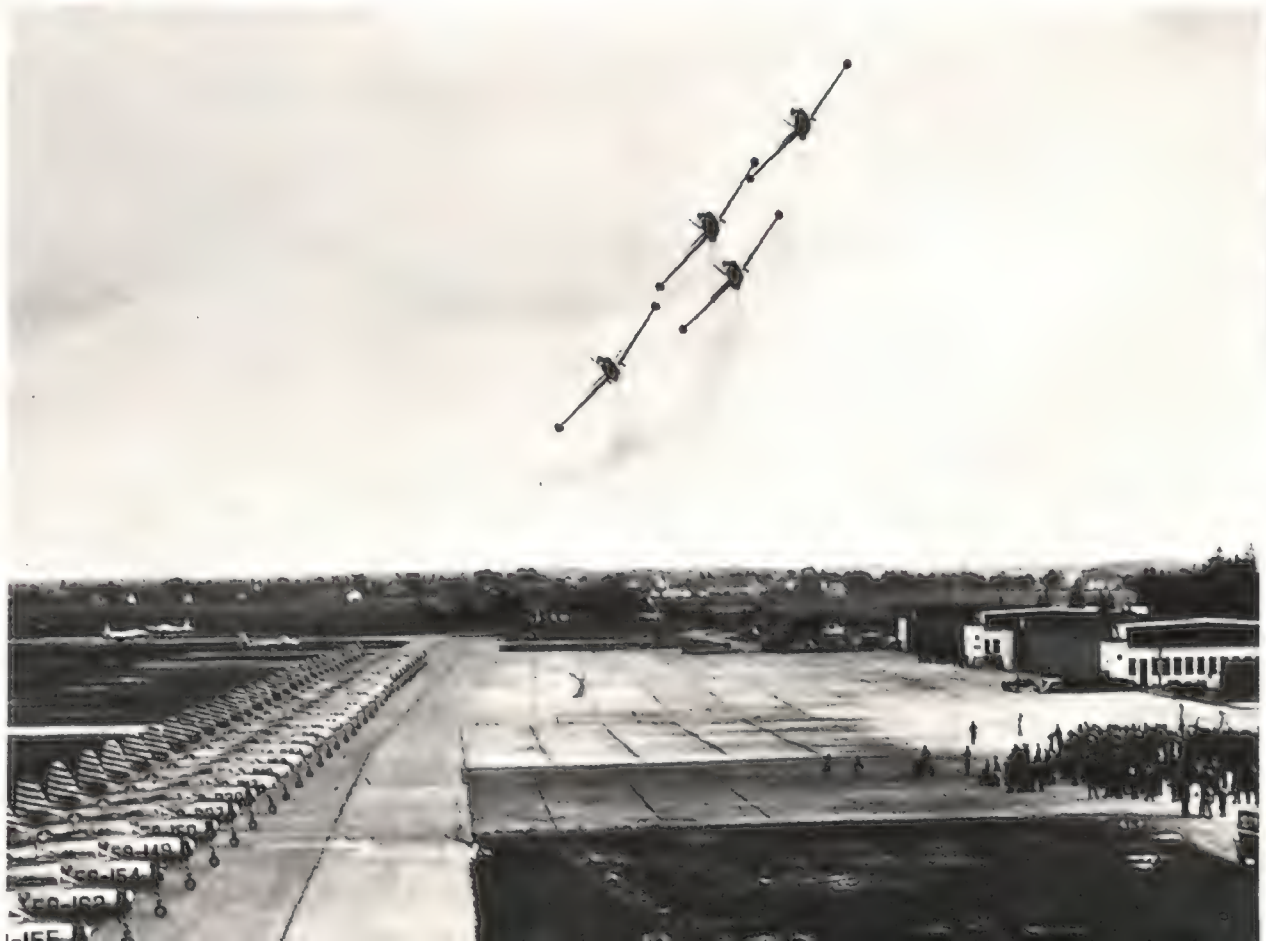
The increased performance capabilities of their aircraft demanded new flying techniques, and the Acrojets helped develop techniques for instrument landing approaches when flying to airports equipped only with old four-course radio range transmitters—technology that dated from the 1930s. At that time, propeller-driven craft began instrument approaches from about 2,000 feet, while jets began theirs as high as or higher than 20,000 feet and came in fast to save fuel. The pilots realized they needed a way to locate and approach airports from high above the cloud cover they so often encountered when travelling to civilian airports for airshows. The four-course transmitter had a cone of silence at the center, where the beacon was. The pilots would try to cross the cone of silence at 20,000 feet. Once they found that spot, they would begin descending away from the field to 10,000 feet. They then would start a left-hand turn and swing back toward the instrument runway, slowing and descending to 2,000 feet. "Then it was 'Level off, slow the airspeed, fly over the cone of silence, go slower, drop the landing gear, and lower flaps,' " Bolt says. This outbound descent procedure was also being tested by the Air Force at its instrument flying school, even as the Acrojets were using it to avoid missing a show because of bad weather.

PATCH COURTESY "BILL" AND "BUCK" PATTILLO

Life on the road as a demonstration pilot was exhausting in itself, but was made even worse because the pilots often returned from performances at 10 or 11 o'clock on a Sunday night, only to have to awaken Monday morning at five o'clock to prepare for routine training missions.

Despite the hardships, Bolt and his fellow demonstration pilots didn't complain. "We were too happy doing what we were doing... Maneuvering in a tight formation with jet airplanes had never been done before."

For the first time, pilots could bring their aircraft within inches of their team members' aircraft because there was no danger of propeller strikes. But despite the greater performance, the P-80 got mixed reviews. The problem wasn't the fast and slippery airframe, but the cranky and troublesome engine. "The acceleration of the first old J-33 [installed in the P-80] was extremely slow," Bolt says. "When you push the throt-



COURTESY "BILL" AND "BUCK" PATTILLO

tle in a prop craft, there's an immediate response. But with the jet that didn't happen... . If you just jammed the throttle forward you'd pour so much fuel into the burner cans...there would be no thrust but it would...make the engine quit. You had to be very, very careful."

Likewise, the early jets were slow to respond to deceleration commands, and a pilot flying wing could easily be thrown out of formation by too much speed. Bolt says slowing down in the P-80 was like pushing in the clutch of a car going downhill: "You had to hope everything would get out of the way," he says. In 1949, Air Force pilots would receive the F-80C, which had considerably more power (4,600 pounds of thrust instead of 3,800) and handled much better in formation flying. But they came a little late for the Acrojets. Not long after the team received new F-80Cs, the buildup for the Korean War meant that pilots were volunteering for combat duty and aircraft were needed elsewhere as training and deployment tempos increased. The Acrojets were disbanded that year.

At one of their last shows, the Acrojets shared the billing with aerobatic teams flying piston-powered aircraft. The Navy's "anchor-clanker" precision team, flying F8F Bearcats, called themselves the Blue Angels, so an Air Force team in F-51 (formerly P-51) Mustangs performed as the Red Devils.

Early in 1949 many of the Air Force's stock of F-51s and related assets at Williams Air Force Base were transferred to Las Vegas Air Force Base in Nevada (now Nellis), to form a cadet training school. The school's commander, World War II ace Lieutenant Colonel John B. England, wanted to create an aerobatic team. England, who had an eye for the theatrical, named them the Red Devils and had the Mustangs' prop spinners painted in red-and-white spirals and the pilots dressed in flashy red flight suits. The four-man Red Devils acted as a recruiting aid and had a lot of enthusiastic fans.

"The P-51 was known to everyone as the sexiest-looking plane ever, the preeminent fighter of World War II," says retired Air Force Colonel Alexander P. Butterfield, who later flew for the Skyblazers. "It had one seat and a huge Rolls-Royce engine, and even though it was fast, it was slower than the jets."

Despite having been overtaken by the jet engine, the P-51 had a shorter turning radius, which paid off for audiences. "You could sit in the bleachers and the whole show was right there in front of you. It didn't get out of your peripheral vision," Butterfield says.

The team was short lived and ultimately met a fate similar to that of the Acrojets: The Korean War effort meant the aircraft were needed elsewhere.

The Skyblazers, who first flew F-80s (below), were founded by Harry Evans (bottom, middle) and twin brothers Cuthbert "Bill" and Charles "Buck" Pattillo (far left and far right). The team eventually represented the Air Force in Europe, but still had to scrounge funding, aircraft, and support equipment.

COURTESY "BILL" AND "BUCK" PATTILLO (2)

At the same time some of the Stateside teams were disbanding, the Skyblazers began flying demonstrations before millions of spectators in Europe and North Africa and earned the widest recognition of any pre-Thunderbird Air Force jet acrobatic team. The team was born in the skies over Malta; the three founders were Captain Harry Evans and First Lieutenants Cuthbert "Bill" Pattillo and his twin brother, Charles "Buck" Pattillo. As members of the 22nd Squadron, 36th Fighter Wing, based at Fürstenfeldbruck, they traveled far for gunnery practice.

The Pattillo twins, natives of Atlanta, were virtually inseparable. They entered the Army Air Forces in 1942, served together, and earned the same honors and decorations, both flew wing on Thunderbird teams, and are today enjoying their retirement in Florida—across the street from each other.

"While our squadron was at Malta for air-to-air gunnery training in the spring of 1949, we would do what most fighter pilots do at the end of an air-to-air mission: rat-race around and simulate a good dogfight," Bill Pattillo says. "One day, the discussion turned to formation flying... ." The Pattillos had seen the Acrojets perform Stateside and knew they could do as well or better in the skies over Europe. "Harry began practicing formation rolls and loops, et cetera, with Bill, I, or both on his wing," says Buck Pattillo. "By the time the squadron left Malta [we] had developed some routine maneuvers as a three-ship flight. At first the group and wing 'wheels' frowned on it, but after a while they accepted the fact that what we were doing was safe and gave their tacit approval."

A fourth pilot, Captain Vincent "Flash"

Gordon was added as slot, the position behind and between the other three aircraft in a four-ship diamond. The team "mutually invented and perfected" enough maneuvers for a 15- or 20-minute show, and someone coined the name "Skyblazers" to describe the pilots' electrifying effect on bystanders. In late-1949 the team began flying at "Fursty" for visiting dignitaries, but they soon widened their field. The shows were considered semi-official, but in addition to sometimes paying their own way, the team sometimes had to scrounge aircraft and ground support from the squadron's regular rosters, especially before the team's reputation began to grow during its earliest days.

The Skyblazers were immensely popular from the start, and flew at prominent airshows around Europe, including the 1950 International Air Exposition in Paris. Later that year, the wing switched from Lockheed F-80s to Republic F-84Es.

Republic "adopted" the team and gave the pilots their own customized flightsuits. As was the case with various flying teams, Skyblazer uniforms evolved in fits and starts—one Skyblazer pilot specialized in the rag-tag look with loosely related shoes and socks. But even pilots in the big leagues wouldn't be immune to misstarts, as when former Thunderbirds commander Jacksel Broughton sought to create a distinct look for his still-new team in 1956. "I was able to con the Air Force clothing lab at Wright-Patterson [AFB] into making us a set of tailored, fancy fabric flying suits," Broughton says. "The first time we wore them, which was at a show, we found out that any undershorts other than plain white boxer shorts were quite visible in the bright sunlight."

Despite sometimes being hard-up for fuel, equipment, and matching uniforms, the Skyblazers performed in France, Germany, England, the Netherlands, Luxembourg, Belgium, Denmark, Morocco, Libya, Italy, Norway, Greece, Turkey, and Spain. Their audiences included influential military officials and even royalty, which eventually led to the Skyblazers' recognition in 1951 as the Air Force's official European demonstration team.

The team got an additional boost that year after Supreme Allied Commander General Dwight D. Eisenhower watched them perform. He realized the Skyblazers were strong representatives of NATO, particularly for countries then receiving the Republic F-84 through the Mutual Defense Assistance Program, and encouraged their performance.

During the 1951 season, the Skyblazers added Captain John O'Brien. In May 1952, tragedy struck. During an airshow in England, O'Brien's aircraft caught fire and crashed as he began a

COURTESY MICHAEL FOX (3)

The Sabre Knights loop over California's San Pablo Bay in 1955 (above). The Knights (left) represented the Air Defense Command and often performed on the same bill as the Navy's Blue Angels. They also proved the F-86D "Sabre Dog" was suitable for formation flying.

pull-up during a bomb burst maneuver. The team continued to fly until August, when the Pattillos and Evans were rotated out of the unit, and then it temporarily ceased to exist.

But a rival Air Force fighter wing, the 86th, stationed first in Neubiberg Air Base in Germany and later at Landstuhl, quickly picked up the Skyblazers torch. No wonder: Former Acrojets pilots Jonesy Bolt and Tommy Tomlinson now served with the 86th, and the wing commander was their champion, Colonel Robert L. Scott Jr. Tomlinson had 1,200 hours in jets, while most pilots were lucky to have 60 to 80 hours.

In late 1952, the Skyblazers nearly changed their name to the Jesters. According to Alexander Butterfield, who would soon fly left wing, there was a contest—with big prize money—for a new name. "The winner was 'the Jesters,' because royalty came to most of these airshows and we often had a king, queen, or prince and we entertained them. They had the name for about a week," Butterfield says, until the commander of USAFE nixed it because it didn't suggest professionalism. "Whereupon my wife said to me, 'You men are so dumb. Why don't you keep the same name. Why throw away two years of publicity?' "

The second incarnation of the Skyblazers featured Tomlinson as leader, along with Butterfield and First Lieutenants Martin "Mo" Detlie and Milton Byron, who performed from January to July 1953, including a demonstration before a crowd of half a million at the 20th International Air Exhibition.

After the tragic crash of Lieutenant Halstead Cross' aircraft during a show, Major William Dillard stood in. From 1956 until January 1962, when the Skyblazers were finally disbanded, the team rotated among various air wings at bases around Europe.

Highly skilled and serious about their role in building post-war confidence in Europe, Skyblazer pilots still made time for fun. Both Butterfield and Dillard claim credit for introducing the ape masks that they would sometimes slip on under their helmets before taxiing in. At one French civilian airport they caused a sensation when curious throngs pushing close to the jets saw gorillas at the controls. The frightened mechanics dropped the wands they used to guide the aircraft and ran. They punished the pranksters by refusing to service the airplanes, and the Skyblazers had to cool their heels in Marseilles for two days.

For the most part, though, Skyblazer pilots were popular with their European audiences. "It made a lot of friends for this country. What people thought of our country depended on us," says Bill Dillard, who at age 75 still pilots a Piper Cherokee and does loops, rolls, and Immelmanns in his single-seat Midget Mustang. "I still consider it the highlight of my career."

In May 1953 an order—mysterious in origin, but succinct in purpose—was given to the wing commander at Luke Airfield, Arizona, who was ordered to form a "dedicated" jet acrobatic team with its own aircraft and ground crew and be ready to perform in three weeks. The new team would become the Thunderbirds.

Despite the coming of the Thunderbirds, some Air Force aerobatic demonstration teams continued to fly. The Skyblazers performed in Europe for nine more seasons. The Acrojets and the Red Devils were long gone, but such aerobatic teams as the Minute Men, the Black Knights, the Sabre Dancers, the Four Horsemen, and the Guardian Angels all flew for the first time in the mid-1950s. The Sabre Knights—one of the best-known Stateside teams—were formed at Hamilton AFB by former Skyblazer Vince Gordon, and proved that the tricky F-86D, known as "The Sabre Dog" and featuring a distinctive black radome on its nose, could be flown in formation. In the mid-1950s the Minute Men represented the Colorado Air National Guard, while other teams flew aircraft unusual for demonstration teams: The Four Horsemen flew Lockheed C-130s in formation maneuvers, and the five-ship Black Knights flew Martin B-57 medium bombers.

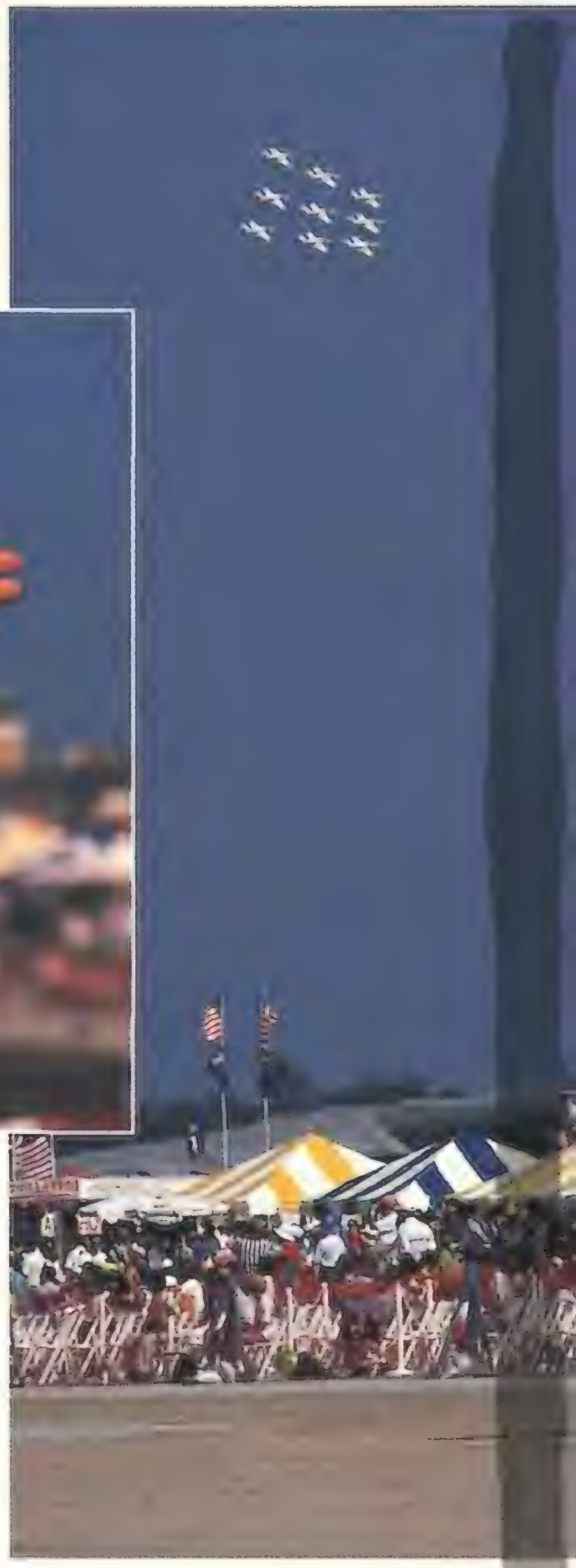
The original Thunderbirds gained direction from two pioneering Skyblazers: Buck and Bill Pattillo. The new team would have dedicated support—gone were the days of borrowed aircraft, equipment and after-hours training.

But also gone were the days of mismatched socks, see-through white flightsuits, and ape masks. And, perhaps, some of the fun.

RICHARD VANDER MEULEN

Poor no more: Today's Thunderbirds and their F-16s have support teams and promotion worthy of rock stars.

The Voice



An airshow without an announcer is like a movie without a sound track.

–Ancient Chinese proverb

by Frank Kuznik

Photographs by Medford Taylor

Strike up the polkas, throw a kielbasa on the grill, and get your videocams ready for another thrilling race against Big Bubbinski, the world's largest biplane. Yesterday, the opening day of the Neptune Festival Air Show at Naval Air Station Oceana in Virginia Beach, Big Bubbinski lost a race against base commander Eric "Sodbuster" Benson, who was motoring down the runway in a John Deere 4 x 2 golf cart. Today, the bulky Russian Antonov An-2 is racing the 150 yards with ShockWave, a semi-truck with three jet engines strapped on the back. As the aircraft floats into position, the truck huffs and chuffs and explodes from the starting line in a huge burst of flame, popping a victorious drag chute seconds later while the Antonov labors far behind. The crowd howls and cheers as the biplane departs in a blast of polka music.

"There goes Big Bubbinski, at a very high rate of speed," chortles Ray Norton, the backup announcer.

"Relative to what?" cracks lead announcer Frank Kingston Smith. "Molasses in the winter?"

Smith let Norton read the act's opening narrative for the Polish-built An-2, deeming the references to the airplane running on "kielbasa grease" too undignified for a professional. A 22-year vet-

eran of airshow announcing, Smith is one of the premier voices on the circuit, his authoritative delivery a perfect match for deafening displays of air power. As such, he's one of a small fraternity of pitchmen who orchestrate the jumble of promotion, advertising, aviation lore, and aerial derring-do that makes up a contemporary airshow.

"I've heard it said that the most important airshow performer is the announcer," says John Cudahy, president of the International Council of Air Shows (ICAS). "A single pilot can neither make nor break a show. But a good announcer can turn an airshow into a wonderful experience."

"The announcer is the link that makes the whole show work," says Jerry Van Kempen, a 20-year veteran. "I can make a bad act look damned good. And I can make a good act look better."

As a gaggle of Canadian Snowbirds wheels around for their next maneuver (above), Frank Kingston Smith (left) works the crowd at Virginia Beach with a marathon riff on aircraft descriptions, performer profiles, war stories, lost-child announcements, directions to the Porta-Johns, and, above all, plugs for sponsors.

CAROLINE SHEEN

It takes more than airplanes to make an airshow. At the Reno Air Races, a Las Vegas showgirl makes a low pass at the box seats at the Reno Air Races (left). But the real crowd pleasers are the military air power demonstrations, like the F/A-18s roaring o'er the ramparts at the Miramar Marine Air Corps show in California (opposite).

Certainly no announcer will ever be accused of lacking an ego, which is critical to the task of standing in front of huge crowds and entertaining and educating them for hours on end. Smith is known in the business as the man whose ego precedes him by three days. Danny Clisham, who has been on the circuit for nearly 30 years, likes to send out publicity stills of himself wearing his signature white dinner jacket and boutonniere, standing underneath the famous hillside "Hollywood" letters.

"The fact is, we're in show business," says Clisham. "It just so happens that we specialize in entertainment with airplanes. But first and foremost, it's entertainment."

The brotherhood of professional airshow announcers is small. About 40 are registered with the ICAS, and they work perhaps two-thirds of the 450 annual U.S. and Canadian airshows. The smattering of other announcers is made up of radio or television personalities, recruited on the theory that a local celebrity will bring out crowds, regardless of his knowledge (or ignorance) of aviation. But that's a vanishing group.

"People are realizing it doesn't make sense to spend $90,000 on performers, then have an announcer who's simply not capable of describing properly what's going on," says Cudahy.

A top-flight announcer commands $2,500 to $6,000 a show, depending on its length and complexity. Pros like Frank Kingston Smith and Van Kempen usually work one to two dozen shows a year, though the number can vary greatly. Bill Bordeleau, a Wisconsin-based announcer who hauls along his own sound system, and Gordon Bowman-Jones, who works internationally, will do up to 35. The bulk of that tends to be repeat business.

Typically, airshow announcers are pilots or aviation devotees whose love for flying led to an announcing opportunity. Smith got hooked at 13, when his father bought a Cessna 140 and took him on his first airplane ride. Though he chose a career in radio and TV broadcasting, Smith got a pilot's license and flew as a hobby. In 1977 a friend and

aerobatics performer asked Smith if he would narrate his act, and over time the favor grew into bookings for other acts and eventually entire shows.

Bowman-Jones, also a pilot, had done some aerobatic training with a friend who asked him to narrate his performance at a northern California airshow in 1971. Australian by birth, Bowman-Jones has a distinctive and engaging accent, and was immediately asked to do other acts (though once a customer complained, "How come they've got a fish-and-chips guy announcing American airplanes?"). By 1979 he was doing eight shows a year, all for free.

"The straw that broke the camel's back came when I turned up at one of the shows and the fellow at the gate said, 'That will be eight dollars,' " Bowman-Jones says. "I said, 'But I'm the announcer.' And he said, 'Too bad, it's eight dollars, like everybody else.' I determined at that point to start charging."

American Airlines pilot Clisham fell in love with airplanes as a kid. By the time he was 21, he was shuttling airplanes around the country for airshow pilots and dreaming of what he would say if he ever got on the announcer's stand. His opportunity came at a show in Elkins, West Virginia, when it was clear that a local TV news broadcaster was in over his head. "He was a nice guy, but when the planes got up in the air, all he could say was, 'Here it comes!' and 'There it goes!' " Clisham says. "I went up behind him and said, 'Let me

CAROLINE SHEEN

An airshow announcer is as much a performer as the pilots whose acts he narrates, and accordingly, must put in the requisite hand-shaking, picture-posing, and autograph sessions (above and opposite).

whisper the maneuvers to you, and you can pass them on to the crowd.' He turned to me bug-eyed, like a horse in a barn fire. He took the microphone, thrust it into my chest, and all I could see was his heels disappearing through the crowd."

Clisham went to work for Johnny "Skyrocket" Morgan, a promoter so named for his stint as a children's TV show host who dressed in a helmet, Lone Ranger mask, and silver-sequined jumpsuit. Airshows are more professional operations these days, but there's still plenty of the Skyrocket spirit in the attendant hoopla—the carnival rides, bands, fireworks, bad food, and, droning above it all, the Voice, as insistent and repetitive as late-night car dealer ads. The key to successful announcing is the ability to weave all the promos and announcements and acts into a seamless narrative that sounds like a chatty, well-informed commentary rather than an endless commercial.

Above all, airshow announcing demands an extensive knowledge of aircraft and airshow performances. If a pilot hands you a set of Aresti diagrams —squiggly shorthand for aerobatic maneuvers—you better be able to follow them during the routine. And if the weather turns bad or there's dead time between acts, you better have a head full of engine trivia and combat records and historical footnotes and funny stories—for as long as it takes.

"You've got to be chief cook, babysitter, bottle washer, and everything else out there," says Bordeleau. "You have to get the announcements in, and the lost kids, and 'No smoking around the static display aircraft,' and 'Now look to your left, ladies and gentlemen' while the next act is taxiing out. It takes practice to get that flow."

And of course a smart announcer keeps plugging the sponsors.

"It's not the Oceana airshow, it's the Exxon 1998 Neptune Festival Airshow," says Smith in his best radio broadcaster delivery. "I make real sure I get the sponsor's name in every time I say it. Meanwhile, the people from Exxon are back there happier than pigs in poop. And if they're happy, they're going to come back next year and spend more money. So the airshow's happy. And I'll get asked back."

One of the biggest shows on the East Coast, Oceana is a jam-packed but tightly run military operation that brings the hidden work of announcing into sharp focus. Smith arrives at the show with three-ring binders stuffed with fact sheets, biographies, aerobatic routines, and prepared scripts, particularly for the military performers. He spends the day before the show collecting and organizing a ton of additional information,

ranging from sponsors and concessions to the names of the pilots in every airplane.

Every morning begins with the air boss—the person who will actually direct the show—holding an 8:00 a.m. briefing for pilots and other performers, after which pilots give Smith last-minute changes in personnel and routines. Then he drives to the announcer's stand, where on the first day he taped down a dozen sheets of paper (photocopied, so there's no ink to run if it rains) with all the other essential show information—sponsors, base officers, where to find programs/restrooms/medical tent/diaper-changing tent, followed by more sponsors, airlines plugs, information on rides and booths and static displays... and on and on.

"I could never in my life walk into an airshow and just do it," Smith admits. "But the hard work is what I do before I go out on the stand. Once I'm out there, it's easy."

Certainly Smith makes it look easy, with his encyclopedic knowledge of aircraft and performers and 29 years of broadcasting experience. Smith can segue from red-hot narration for an F-14 demonstration to an explanation of vapor trails ("They're literally squeezing the moisture out of the air!") to wacky disc jockey-style voice imitations without missing a beat. And filler? Give Smith an hour of cloudy skies and you'll hear everything from bad jokes about trying to talk the weather away with all the hot air to plugs for his wife's embroidery business. At last year's Oceana show, the Snowbirds, the Royal Canadian Air Forces' demonstration team, gave him a great excuse to talk about his wedding at an airshow in Kalamazoo, where the Snowbirds dedicated a smoke-trail heart to the newlyweds.

Keeping the crowd engaged is the most difficult part of announcing, and there's nothing announcers won't do—however corny or contrived—to hold your attention. Smith is great at fore-

head-slapping reactions. "That one hurt me," he'll wince after a particularly flashy air maneuver. Or after a sneak pass by an F-14 rattles the stands and sets off car alarms, he'll howl, "That was a pucker factor nine!"

Van Kempen finds it helpful to draw analogies. "If you use all that technical crap on a guy with a straw in his mouth looking up in the air, you're just whistling right over his head," he says. "You need to paint a picture. When I describe a snap roll, I tell the crowd it's like turning a corner too fast in your car. They understand exactly what I'm saying, especially if they live in Minnesota, where we've got lots of ice and snow."

CAROLINE SHEEN (2)

Humor is the staple of the business, though no one on the Comedy Channel is sweating the competition. Van Kempen's trademark line, after a heart-stopping maneuver: "That's hard on the Fruit of the Looms." Bowman-Jones likes to slip in sly malapropisms. "Like when I talk about the U.S. entering World War II, I'll often say it was the result of the Japanese attack on Pearl Bailey."

Van Kempen and Bordeleau occasionally work shows together, and they have routines that play on regional rivalries. "You know, we make all those toilets up here," Bordeleau will say, a reference to the Kohler company.

"Yeah, you people in Wisconsin invented the toilet," Van Kempen shoots back. "But in Minnesota, we're the ones that cut the hole in it."

But topical humor sometimes backfires. When Bert Lance, budget director for President Jimmy Carter, was immersed in financial scandal, Bordeleau had a standard line. "When I was encouraging people to buy souvenirs, I'd say, 'We'll take cash, credit cards, pesos—anything but a check from Bert

Announcer Jerry Van Kempen takes a break in the Red Baron Squadron hospitality suite. "I can make a bad act look damned good," he says, "and I can make a good act look better." Announcer Sandy Sanders (below, in print shirt) has been making them look good at the Reno races for 35 years.

Smith exhorts applause for wingwalker Teresa Stokes atop Gene Soucy's Ag Cat as the duo taxies by. On the airshow circuit, talk is not cheap. Smith and his peers get up to $6,000 a show. The chief occupational hazard for announcers? A stiff neck (below).

Lance.' " Bordeleau didn't know Lance was from Rome, Georgia, and when he used the line at a show there, he was besieged. "I had a bunch of farmers on my ass after the show telling me, 'If it hadn't been for Bert, old boy, I wouldn't be farming today.' I was chastised good in the paper on Monday morning, and never went back to Rome to do a show."

Humor can evaporate quickly at airshows, with their split-second potential for disaster. Veteran announcers have all witnessed fatal accidents, and in some cases examples of how not to handle them. "I attended a show once where a plane crashed," says Bowman-Jones, "and the announcer, who happened to be a local weatherman, started to cry and asked everybody to get down on their knees and pray."

The mark of a professional announcer is the ability to stay calm and keep the situation from becoming overly emotional. "I immediately stop using the pilot's name, drop my voice about an octave, and gently reassure people that everything possible is being done," says Bowman-Jones. "I explain an emergency plan that has come into play, and ask everyone to stay back from the area. I ask parents to reassure their kids that everything is okay, and put on some soothing music."

"That's when you really earn your money," says Clisham. "It's the hardest money you'll ever make, and it's the longest two hours of your life."

Smith has witnessed more accidents than he cares to count, many involving friends. "No matter how close you were to somebody, you have to keep going," he says. "I'm working on adrenaline when it happens. Then I go home and fall apart."

Tragedy is no more than idle conversation on the final day of Oceana 1998, a perfect blue-sky Sunday highlighted by the appearance of Triton's Court, a group of high school beauty queens. Big Bubbinski races a marathon runner and loses. The Canadian Sky Hawks parachute to the theme music from "Mission Impossible," trailing pink smoke and giant Canadian and American flags. Aerobatic star Patty Wagstaff departs from her usual routine with a dazzling series of spins and torque rolls that quickly tongue-ties Smith.

"Anything to confuse old Frank," he says, then turns to the crowd to elicit applause when Wagstaff lands. "How about that?" he yells. *"Woof!"*

Airshows! Coming Soon

ALABAMA
Anniston — Apr. 15–17
Alabama Int'l. Airshow
Maxwell AFB — Sept. 25
Maxwell Airshow (Thunderbirds)

ALASKA
Juneau — Apr. 24 & 25
Southeast Alaska Airshow

ARIZONA
Luke AFB — Nov. 13
Luke Day (Thunderbirds)
Page — Oct. 1 & 2
Page-Lake Powell Air Affair
Sierra Vista — Oct. 23 & 24
Sierra Vista Benefit Airshow (Thunderbirds)
Scottsdale — Oct. 16 & 17
Scottsdale AirFair

ARKANSAS
Fort Smith — Nov. 6 & 7
Fort Smith Airshow (Thunderbirds)
Little Rock — Oct. 23 & 24
Little Rock AFB Open House (Blue Angels)
N. Little Rock — Sept. 18 & 19
Central Arkansas Airshow '99

CALIFORNIA
Atwater — Sept. 10–12
Golden West EAA Fly-In
Camarillo — June 19 & 20
Air Show Expo
Edwards — Oct. 9 & 10
Edwards AFB Open House (Thunderbirds)
Hayward — Sept. 3 & 4
Hayward Air Fair
Lemoore — June 13
Central Valley Airshow (Blue Angels)
Long Beach — Oct. 9 & 10
Pierfest Sea and Airshow
Madera — May 22
Wings, Wheels, & Power
March ARB — Apr. 10 & 11
Airfest (Thunderbirds)
Marysville — June 26
Air Expo
Mountain View — June 18-20
Wings Over Moffett
Pt. Mugu NAWS — Apr. 24 & 25
Point Mugu Open House (Blue Angels)
Paso Robles — June 12
26th Annual Paso Robles Airshow
Reedley — May 1
Journey Into Sherwood
Salinas — Oct. 1–3
California Int'l. Airshow (Blue Angels Oct. 2 & 3)
San Diego — Apr. 29–May 2
Wings Over Gillespie
San Diego — July 30–Aug. 1
Miramar MCAS Airshow (Blue Angels)
San Diego — Oct. 2 & 3
San Diego Airshow (Snowbirds)
Santa Maria — Aug. 21 & 22
Annual Warbird Round-Up
Santa Rosa — Aug. 21 & 22
The Magic of Flight
Stockton — Sept. 24–26
Wings Over Stockton
Torrance — July 10 & 11
Torrance Air Fair
Travis AFB — June 26 & 27
Air Expo (Thunderbirds June 27)
Van Nuys — July 17 & 18
Aviation Expo '99
Watsonville — May 28–30
Wings of History

COLORADO
Aspen — Sept. 28
Aspen Airshow (Snowbirds)

DELAWARE
Dover AFB — May 15 & 16
Open House (Blue Angels)

FLORIDA
Eglin AFB — Mar. 27 & 28
Eglin Airshow (Thunderbirds)
Ft. Lauderdale — May 1 & 2
Shell Air & Sea Show (Thunderbirds)
Jacksonville — Nov. 6 & 7
Jacksonville Airshow (Blue Angels)
Lake City — Nov. 13 & 14
North Florida Airshow
Lakeland — Apr. 11–17
Sun 'n' Fun EAA Fly-In
MacDill AFB — May 8 & 9
MacDill Airfest (Blue Angels)
New Smyrna — Apr. 10 & 11
New Smyrna Beach Air Festival
Panama Beach — Sept. 25 & 26
Panama City Beach Aerial Circus
Patrick AFB — Apr. 24 & 25
Patrick Open House (Thunderbirds)
Pensacola NAS — Nov. 12 & 13
Blue Angels Homecoming
Pensacola Beach — July 10
Pensacola Beach Airshow (Blue Angels)
Punta Gorda — Mar. 27 & 28
Florida Int'l. Airshow
Stuart — Nov. 13 & 14
Stuart Airshow
Zephyrhills — Nov. 5 & 6
Air & Car Show

GEORGIA
Athens — May 22
Athens Airshow
Moody AFB — Oct. 30 & 31
Moody Open House (Blue Angels)
Thomaston — Sept. 11 & 12
Wings Over Dixie
Vidalia — May 1 & 2
Vidalia Onion Festival Airshow

IDAHO
Boise — June 12 & 13
Idaho Aerofair
Mountain Home — May 8 & 9
Mountain Home AFB Airshow (Thunderbirds May 9)

ILLINOIS
Bloomington — July 17 & 18
Prairie Airshow (Thunderbirds)
Chicago — Aug. 21 & 22
Chicago Air & Water Show (Thunderbirds)
Rantoul — Aug. 6–8
Rantoul Airshow
Springfield — Sept. 24–26
Air Rendezvous

INDIANA
Elkhart — June 5 & 6
Elkhart Airshow
Goshen — Aug. 14 & 15
Skyfest Michiana
Grissom ARB — Aug. 21 & 22
Grissom Air Reserve Airshow

IOWA
Davenport — July 16–18
Quad City Airshow (Blue Angels July 17 & 18)
Des Moines — Sept. 25 & 26
Wings, Wheels, & Water Festival
Independence — July 3
1999 Airshow
Newton — July 23–25
Newton Airshow
Sioux City — Oct. 2 & 3
Mid-America Airshow

KANSAS
Great Bend — Oct. 2 & 3
High Plains Airshow (Thunderbirds)
McConnell AFB — June 16
McConnell Open House (Thunderbirds)

KENTUCKY
Prospect — Apr. 17
Thunder Over Louisville

LOUISIANA
New Orleans — Oct. 29–31
N'awlins Airshow (Thunderbirds)

MAINE
Brunswick — July 24 & 25
Great State of Maine Airshow (Blue Angels)

MARYLAND
Andrews AFB — May 14–16
Joint Services Open House (Thunderbirds)
Frederick — Aug. 20–22
Wings of Freedom
Patuxent River — May 29 & 30
Patuxent River NAS Airshow (Blue Angels)
Westminster — June 19 & 20
Jack B. Poage Airshow

MASSACHUSETTS
Falmouth — Aug. 21 & 22
Cape Cod Airshow (Blue Angels)
Westfield — Aug. 28 & 29
Great New England Airshow (Thunderbirds)

MICHIGAN
Battle Creek — July 3–10
Balloon Championship/Airshow (Snowbirds July 3 & 4, Thunderbirds July 3-5)
Detroit — June 26 & 27
AirMichigan Airshow
Muskegon — July 16–18
Muskegon Air Fair
Selfridge ANGB — May 26
Air National Guard Airshow (Snowbirds)

MINNESOTA
Mankato — June 5 & 6
Airfest (Thunderbirds)

to a Field Near You!

MISSISSIPPI
Biloxi — Nov. 6
Keesler AFB Open House
Greenville — Sept. 3-6
Sky Parade

MISSOURI
Cape Girardeau — July 10-11
Cape Girardeau Airshow
Chesterfield — Sept. 4–6
St. Louis County Fair & Airshow
Columbia — May 29 & 30
Salute to Veterans Celebration
Kansas City — Aug. 14 & 15
Aviation Expo
St. Louis — July 3–5
Fair Saint Louis Airshow
Whiteman AFB — Aug. 14–18
Whiteman Airshow
(Thunderbirds Aug. 14 & 15)

NEBRASKA
Offut AFB — Aug. 28 & 29
Thunder Over the Heartland

NEVADA
Fallon — May 1 & 2
NAS Fallon Airshow (Blue Angels)
Nellis AFB — May 8
(Thunderbirds May 8)
Reno — Sept. 16–19
Nat'l. Championship Air Races
(Thunderbirds Sept. 18 & 19)

NEW JERSEY
Medford — Sept. 18 & 19
Air Victory Museum Air Fair
Millville — May 29 & 30
Seventh Annual Wheels & Wings Show

NEW MEXICO
Cannon AFB — June 13
Cannon Open House (Thunderbirds)
Kirtland AFB — Oct. 16 & 17
Kirtland Open House (Blue Angels)

NEW YORK
Elmira — Sept. 17–19
Wings of Eagles
Niagara Falls — July 9-11
Thunder Over Niagara (Thunderbirds)
Poughkeepsie — June 11-13
Great Hudson Valley Airshow
Rochester — Aug. 28 & 29
Rochester Int'l. Airshow (Blue Angels)
Syracuse — Sept. 11 & 12
Syracuse Int'l. Airshow

NORTH CAROLINA
Concord — May 1 & 2
Wendy's Air & Speed Show
Goldsboro — Oct. 30
Seymour Johnson AFB Airshow
Havelock — Apr. 9–11
MCAS Cherry Point
Celebration of Flight (Blue Angels)
Hickory — May 15 & 16
Warbirds Over History
Wilmington — Sept. 25 & 26
Carolina Air Expo (Blue Angels)
Winston-Salem — Sept, 11 & 12
Winston Air Classic

NORTH DAKOTA
Fargo — Aug. 21–23
Fargo AirSho

OHIO
Cincinnati — June. 12 & 13
Blue Ash Airport Days
Cincinnati — Aug. 28 & 29
Luken Airfest
Cleveland — Sept. 4–6
Cleveland National Airshow (Blue Angels)
Dayton — July 24 & 25
U.S. Air and Trade Show (Thunderbirds)
Elyria — July 23–25
Aircraft Past & Present
Toledo — Sept. 11 & 12
Food Town Toledo Airshow

OKLAHOMA
Bartlesville — June 4 & 5
National Biplane Expo
Muskogee — Oct. 9 & 10
Airshow Oklahoma
Oklahoma City — June 5 & 6
Aerospace America (Blue Angels)

OREGON
Hillsboro — June 26 & 27
U.S. West Rose Festival Airshow
North Bend — Aug. 28 & 29
Rotary Oregon Coast Air Fair

PENNSYLVANIA
Avoca — July 31 & Aug. 1
Armed Forces Airshow (Thunderbirds)
Beaver Falls — Aug. 14 & 15
Beaver County Airshow
Coatesville — Oct. 2 & 3
Chester County Airshow
Reading — June 5 & 6
World War II Weekend

RHODE ISLAND
North Kingston — June 12-13
National Guard Open House

SOUTH CAROLINA
Charleston — Sept. 26
Charleston AFB Air Expo (Thunderbirds)

TENNESSEE
Halls — Aug. 28 & 29
Airshow '99
Millington — Apr. 17 & 18
Mid South Airshow (Blue Angels)
Smyrna — Sept. 11 & 12
Tennessee Aviation Days (Thunderbirds)

TEXAS
Austin — Apr. 17 & 18
Aerofest
Borger — Aug. 6 & 7
AirFair
Bridge City — May 15 & 16
Aviation Appreciation Days
Dallas — Sept. 11 & 12
FINA Dallas Airshow
Dyess AFB — Oct. 17
(Thunderbirds)
El Paso — Oct. 9 & 10
Amigo Airshow (Snowbirds)
Fort Worth — Oct. 9 & 10
International Airshow
Galveston — Apr. 24 & 25
Lone Star Flight Museum Airshow
Houston — Oct. 16 & 17
Wings Over Houston
La Grange — Sept. 24–25
Fayette Airshow
Longview — July 17–19
Great Texas Balloon Race
Midland — Oct. 2 & 3
Confederate Air Force '99
Randolph AFB — May 22 & 23
(Blue Angels May 22)
San Marcos — Sept. 25 & 26
Gathering of Memories
Sheppard AFB — Oct. 16 & 17
Sheppard Open House
(Thunderbirds Oct. 16)

UTAH
Hill AFB — May 12
Hill Open House (Thunderbirds)
Parowan — July 22-24
Southern Utah Airshow

VIRGINIA
Dublin — Sept. 11 & 12
SkyFest
Langley AFB — Aug. 28 & 29
Community Appreciation Day
Norfolk — Apr. 17 & 18
NAS Norfolk Airshow (Thunderbirds)
Suffolk — Apr. 10 & 11
Suffolk Airshow
Virginia Beach — Sept. 17–19
Neptune Festival, Oceana NAS
(Blue Angels, Snowbirds Sep. 18-19)

WASHINGTON
McChord AFB — June 26
McChord Airshow (Thunderbirds)
Seattle — July 17
Museum of Flight Airshow
Seattle — Aug.7 & 8
Seafair (Blue Angels)
Spokane — May 8 & 9
Fairchild AFB Open House
Tacoma — July 4
Freedom Fair
Tumwater — July 17 & 18
South Puget Sound Airshow
Walla Walla — Oct. 2 & 3
Wings Over Walla Walla
Yakima — June 19 & 20
Yakima Airshow (Blue Angels)

WISCONSIN
LaCrosse — June 18–20
Deke Slayton Airshow
Manitowoc — June 13
Manitowoc County Airport Day
Milwaukee — July 3 & 4
FIRSTAR Fireworks (Blue Angels)
Oshkosh — July 28–Aug. 3
EAA Airventure

AFB — Air Force Base
ANGB — Air National Guard Base
ARB — Air Reserve Base
MCAS — Marine Corps Air Station
NAS — Naval Air Station
NAWS — Naval Air Weapons Station

Schedule information provided by
International Council of Air Shows

Airplanes are key to feeding the hungry in southern Sudan, whether by dropping bagged grains (shooting out of the cargo hold of this Lockheed L-382 Hercules, a stretched version of the C-130), or by landing with more fragile freight, like cooking oil. The de Havilland DHC-5 Buffalo (opposite) is one of the craft flying in the region that can land on the country's numerous unpaved airstrips.

Lifeline

In southern Sudan, a no-holds-barred airlift is all that stands between the people and starvation.

by Carl Hoffman

Photographs by Tim Wright

The drop zone is six miles out and we're in a Lockheed L-382 Hercules, doing 150 mph over the world's largest swamp. When the rear door and ramp open, the heat and humidity pour in like pressurized steam. We're 700 feet above a green sea that stretches forever. Buildings? Telephone lines? Cars? Navigation aids? Not a chance. It's the Middle Ages down there. Veteran Herc pilot Carl Sampson, a good old American boy wearing a blue baseball cap embroidered with "American Embassy," is lining up to drop 35,640 pounds of yellow corn on a place called Yirol.

Welcome to the war on hunger in the Republic of the Sudan, where civil war has left millions starving and set in motion the largest United Nations airlift in history. Based in Lokichokio, or Loki, a dusty Kenyan village of thatch and mud huts set around a 5,970-foot airstrip without lights, radar, or navigation aids, an ad hoc air force flies mainly under the auspices of Operation Lifeline Sudan, a coalition of U.N. relief agencies—most notably the World Food Programme—and 38 non-governmental organizations, such as Norwegian People's Aid and Christian Solidarity International. Between sunrise and sunset seven days a week, some 40 airplanes lap up 52,000 gallons of Jet A-1, drop 100 tons of food, and move a small army of relief workers and war casualties in and out of the largest country in Africa.

Sampson's Herc is part of TransAfrik, an Angola-based charter company under contract to the World Food Programme. The Hercules is one of eight L-382S that, along with two Transavia C-160 Transalls and four massive Ilyushin Il-76s, move most of the operation's food from Loki and other bases in Kenya and Sudan at a cost of $1 million a day. The big transports share Loki's airport and support facilities with de Havilland Buffaloes, Cessna Caravans, and the odd Antonov, Fokker, and DC-3—some owned, some leased, some sub-leased, all operated by various airplane-for-hire companies that are here because of the business that war has created. For the pilots, it's the ultimate bush flying. In this part of Africa, lines are blurred and fortunes made. It's a place where a young pilot can rack up the hours and an old one can captain an airplane long after he'd be grounded at home.

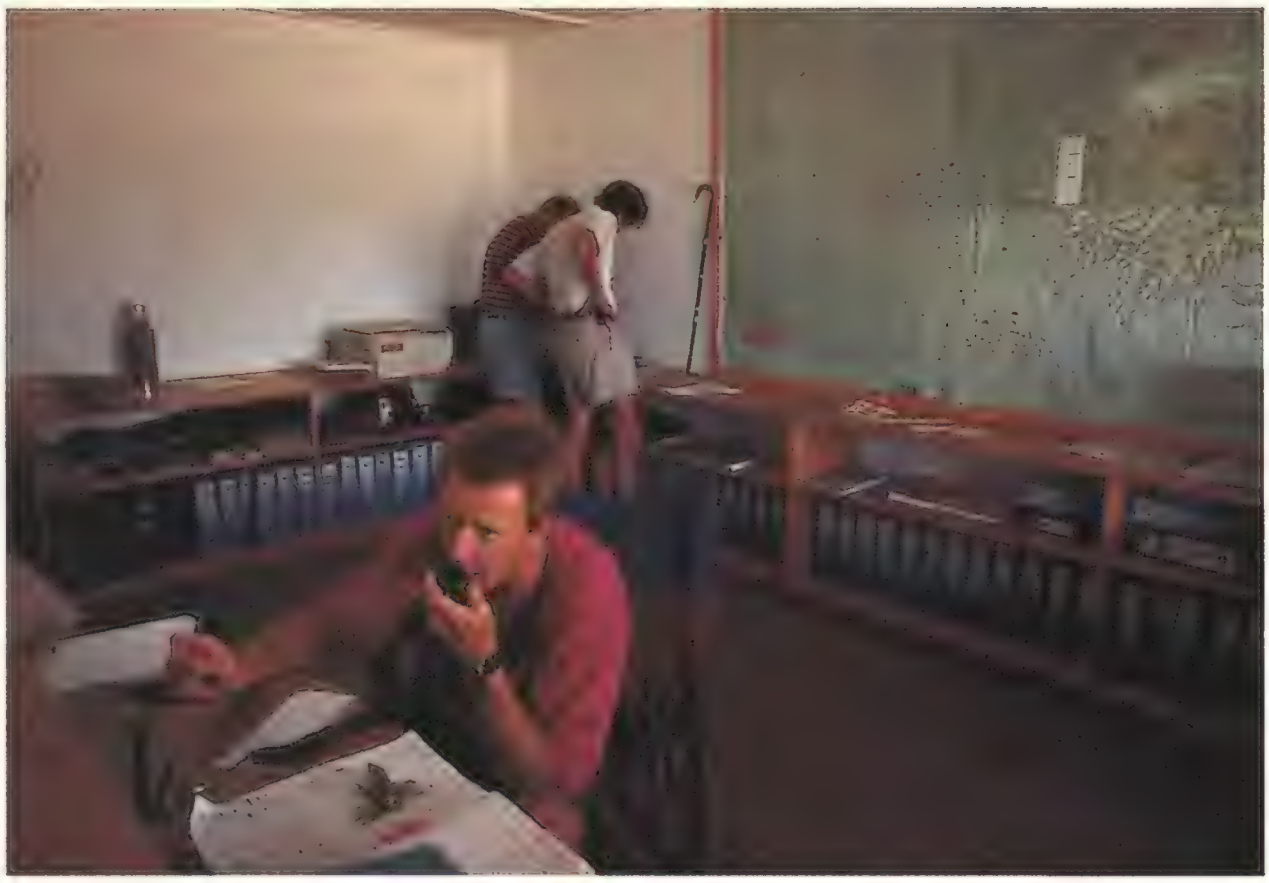
A few days before boarding Sampson's Herc, I'd hitched a ride up to Loki from Nairobi in a Cessna 208 Grand Caravan piloted by Heather Stewart, a gracious, soft-spoken, 58-year-old mother of five who wears pink lipstick and has 15,500 hours of African bush flying in her logbook. Her Nairobi-based company, Trackmark Ltd., has been flying out of Loki since 1989, and Stewart may be the person most responsible for the change in the village. As we climbed over a herd of giraffe gamboling in Nairobi National Park and headed north over the Rift Valley carrying a load of elec-

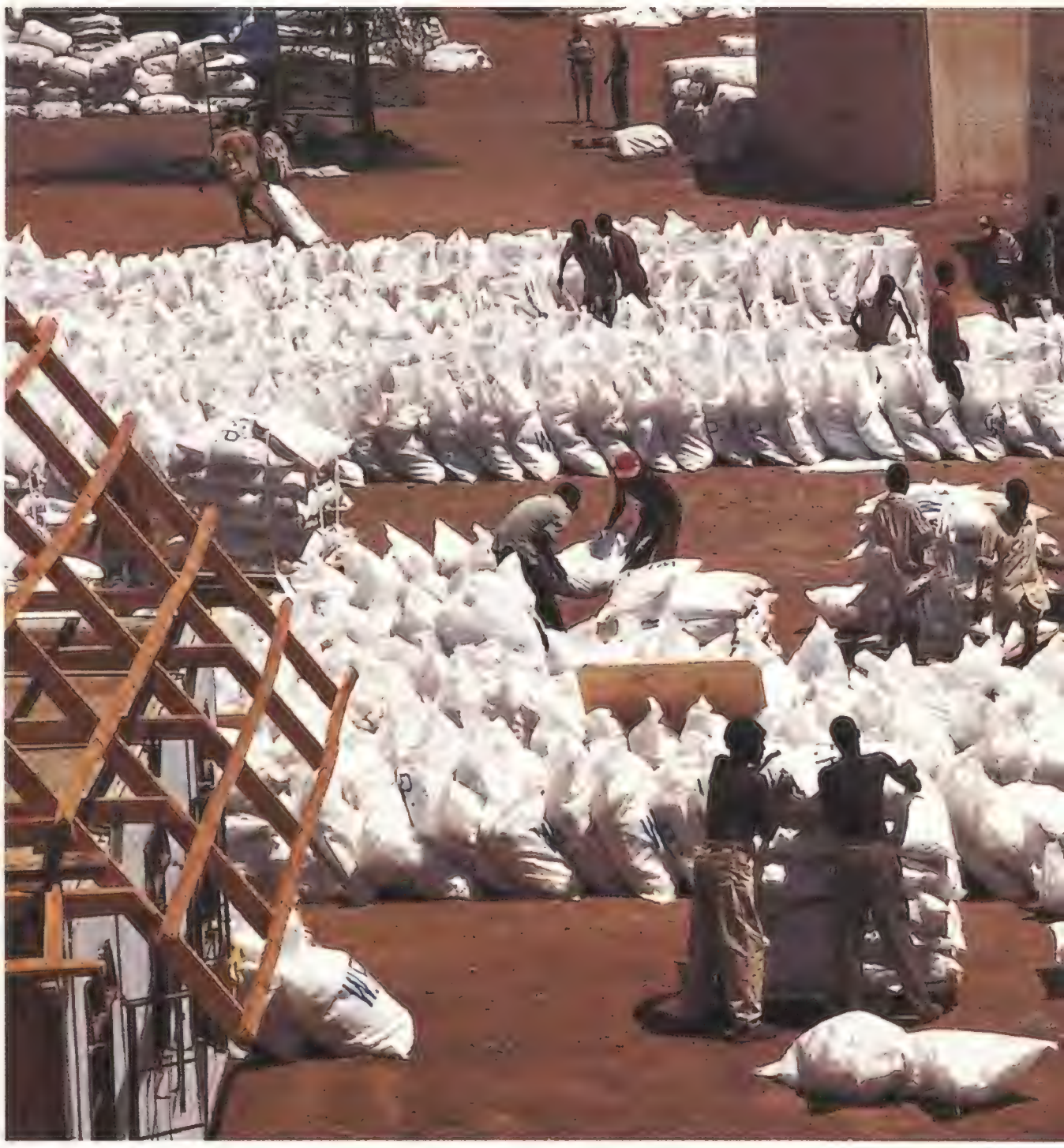
tric fans, beer, mattresses, three journalists, and a pilot returning from a two-week break, she breathed a sigh of relief. "Now that I'm out of the office, I can relax," she said.

A native Kenyan and the daughter of a Scottish-Irish mining engineer, Stewart took her first light airplane ride at 25. She was smitten. Two years later she had her commercial license. In 1972 she leased a Beech Baron and flew into the Sudan for the first time. "A rich American real estate guy, two Kenyans, and an Austrian photographer hired me to fly them in so they could hunt a rare antelope," she said. "I washed their clothes and cooked their food. I had no radio, no GPS, and no radar." Stewart laughed and shook her head. "Now my guys won't even fly from Nairobi to Loki without a GPS!"

Between 1972 and 1983 there was no war in the Sudan, but Stewart busied herself transporting aid workers, missionaries, hunters, and rebels, some of whom are commanders these days. "I met everyone who matters," she said. Since she didn't have clearance from the government of Sudan, she'd fly across the border at 4 a.m. "and get permission from the rebels to land." By the late 1980s she was making big and fast money flying qat, a mild but highly addictive leafy shrub grown legally throughout parts of East Africa and chewed by Africans throughout the continent's northeast corner, or Horn, between Nairobi and Somalia. It was a dangerous job. Qat lasts for only 48 hours after its harvest, and the industry is controlled largely "by the Somali Mafia," Stewart said, "so they try to overload you terribly." Sitting on the ground in Somalia one day in 1989, six machine gun bullets crashed into her wing and one hit her headset—while it was on her head. "After I got shot up I started looking for somewhere else to fly," she said.

That somewhere else was the Sudan, where independence-minded black animists and Christians—mainly Dinka, the largest ethnic group in southern Sudan—had been fighting the politically and economically dominant Arabs in the north since 1956. The war created widespread famine: Crops couldn't be planted or harvested and tens of thousands of people fled into neigh-





Clockwise from bottom: In Lokichokio, Kenya, the World Food Programme stores and packages food for shipment to Sudanese villages. Dispatcher Andy Belcher monitors the status of aircraft en route between Loki and the Sudan. Pilot Heather Stewart founded Trackmark Ltd., the first charter company to fly food from the base.

A young Dinka meets a Hawker Siddeley Andover transport on the airstrip at Mapel.

boring areas already afflicted by poverty and desecrated by war. Seasonal deluges of rain compounded the problem.

By 1989, a growing number of missionaries and other non-governmental charity organizations (such as Catholic Relief Services and Oxfam International) had been drawn to the Sudan and its intractable war. Stewart, knowing the key players on the ground from her earlier flights and having "a good feeling" for the security situation, put out the word to relief organizations that she was willing to fly there. "I was flying with the permission of the rebels, not the government in Khartoum, and in 1989 I brought the U.N. up to Loki to look for a base," she said. "I was in the right place at the right time."

Before the U.N. operation, Trackmark was a one-woman show with a leased Piper Navajo Chieftain and an office manager. Her company now operates nine Cessna 208 Grand Caravans, one Hawker Siddeley Andover, one turbo DC-3, one Hawker Siddeley 748, one de Havilland Twin Otter, and one Beech Super King Air 200. Most are leased, save one Grand Caravan, the HS 748, the Twin Otter, and a half ownership each of two other Caravans. The staff of 120 includes 28 pilots, who hail from the United States, Kenya, Uganda, the United Kingdom, Canada, France, New Zealand, South Africa, and Belgium. In 1997, even before the Sudan airlift ratcheted into high gear, Trackmark flew 6,669 hours, carrying 7,322 passengers and over 6,700,000 pounds of cargo. And that was just in aircraft under contract to the World Food Programme; over half of its flying is for relief organizations that don't fall under the Operation Lifeline Sudan umbrella.

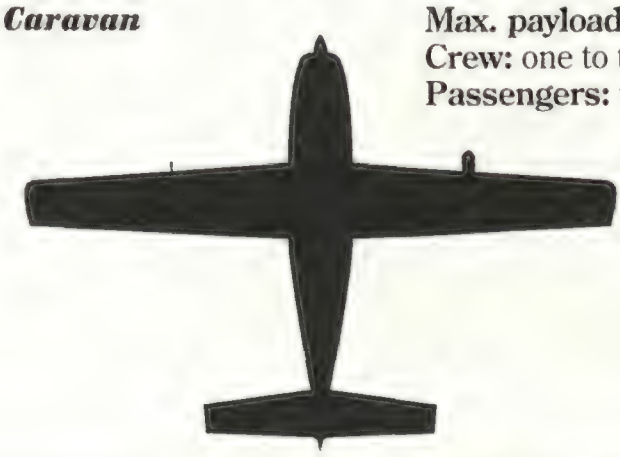
Those are impressive numbers for a single charter company. Worldwide in

1997, aircraft under contract to the U.N. World Food Programme flew 107,368 passengers and about 116 million pounds of cargo. The Programme, which started operations in 1963, first used massive airlifts in Ethiopia in the 1980s. It is the United Nations' frontline food aid organization, employing 4,000 people and, in 1997, spending $1.2 billion to help the needy in 84 countries. Funding for the World Food Programme comes voluntarily from donor nations; the United States, which gave more than $400 million in 1997, is by far the largest contributor.

Operation Lifeline Sudan is the largest current WFP operation, with the goal of feeding 2.6 million people in southern Sudan. It is a scrupulously neutral effort; it delivers food to both government- and rebel-held areas, flying through Sudanese airspace only with the approval of the government of Sudan. The effort waxes and wanes as needed, but since a January 1998 cease-fire between the government and the Sudanese People's Liberation Army in the southwestern province of Bahr al Ghazal, it has gone into overdrive. Feeding off the sizeable U.N. presence, Loki is now home to a throng of non-governmental organizations—not all of whom are connected with Operation Lifeline Sudan—and the charter companies like Trackmark that serve them. Every day non-OLS flights cross the border without government approval, carrying everything from Christian groups who buy slaves (in order to free them) to organizations who open-

de Havilland Canada DHC-5E Transporter (civil version of the DHC-5D Buffalo)

Max. payload: 18,000 lb.
Crew: one to two
Passengers: up to 44



Cessna Caravan

Max. payload: 3,000 lb.
Crew: one to two
Passengers: up to14

With so many different organizations involved in Operation Lifeline Sudan, the base at Lokichokio hosts aircraft from all over. More than 40 airplanes are stationed there, including (from right, clockwise) a Douglas DC-3, two Cessna Caravans, an Antonov An-32, and a Hawker Siddeley Andover.

ly support the Sudanese People's Liberation Army.

The Sudan is a good place for air charter companies to do business. "Somalia was total chaos and you couldn't operate well there at all," said Stewart, "but the war in Sudan is a disciplined war that's going nowhere." Most of the south is controlled by one army, the Sudanese People's Liberation Army, save a handful of garrison towns controlled by the Sudanese government or plagued by the occasional intra-rebel fighting. It's a region with only about two miles of paved roads, so troop movements are slow and relatively predictable. If you've got airplanes, the Sudan is yours.

It's also a vast, complicated, oil-rich country of tribes and passions and of slaves and raiders that has been confounding and beguiling the West for centuries. If you had been an adventurer in the 19th century, you might have accompanied David Livingstone on his expeditions to find the source of the Nile or joined the Sudan Political Service to administer the Sudanese corner of the British Empire. Today's adventurers get into the aid business.

"We get a lot of young guys who just want to build up hours and want to move to bigger planes," explained Stewart as we descended into Loki after the two-hour flight from Nairobi. "But not me. This is all I ever wanted to do. I love this flying."

Carl Sampson does too. "This is the best flying that I've ever done in my

Ilyushin Il-76MD

Max. payload: 103, 617 lb.
Crew: six to seven
Troops: up to 245

Transall C-160D

Max. payload: 35, 270 lb.
Crew: four
Troops: up to 93

life," he says, hunkering down in his seat a few days later for the fast-approaching drop at Yirol, little more than a few huts and bombed-out buildings simmering in the heat. A former U.S. Air Force captain who retired in 1991 after 12 years of flying Hercs, Sampson was eradicating coca crops in Colombia in a DC-3 for "the state department," he says, when the opportunity came to fly his beloved transports for TransAfrik. Trading "a three-bedroom, three-bath apartment overlooking Bogota for a tent," he jumped at the chance. "I wanted to fly Hercs," he says unequivocally. "You can put a Herc on a 3,000-foot dirt strip on a pitch-black night without lights in the mountains. It's the most versatile airplane in the world. For a pilot, there's not another one like it. And the airdrops were a big draw—there's a bit of an art to it."

Indeed, at Loki, the Hercs are at the top of the food chain. Sampson manages to take off from Loki's 5,970-foot runway for his third rotation of the day in 100-degree heat with a gross weight of 140,000 pounds. Loaded behind him in the Herc's belly are 324 bags of corn, 110 pounds to a bag, stacked on inch-thick plywood pallets, nine pallets to a row, or stick, two sticks side by side. The Programme needs to feed people without displacing them, and the most efficient way of bringing large quantities of food into this roadless swamp is to drop it. For that, says Sampson, there's not another airplane like the Herc. And because Western military aircraft are anathema to the Islamic government in Khartoum, those Hercs must be privately owned and flown by civilians.

All of which explains why Carl Sampson is flying over Yirol, homing in on the drop zone with a hot load—an eight-ton stick of pallets held in place by a single nylon strap. One false move on Sampson's part—a bump, a jerk, a quick turn—and the stick might break the strap and rocket out of the back like a runaway train. We're moving at 150 mph and the drop zone is about 300 yards long and 50 wide with an X right in the middle, outlined with old plastic sacks by a U.N. food monitor who was flown into Yirol a few days ago to organize the drop. Children, goats, who knows what all will inevitably be too close to the zone. A two-degree error and it'll be lights out for anyone hit by a 110-pound bag hurtling from the sky. (Four days after Sampson's drop at Yirol, a boy standing in tall grass at another drop zone is killed.)

"Okay, Picasso," Sampson says to his flight engineer, Pompeyo Velasco, "I want you to paint the X with the bags like an artist. I know you can do it. We're one minute to live drop."

Sampson looks at nothing save the instruments registering airspeed, heading, and altitude. Copilot Mario Gomez will work the flaps and Velasco will sight the drop. In the back, loadmaster Fajardo Bong, sporting long black hair and tattoos on his forearms, is poised to slash the strap with a switchblade.

Velasco kneels on the console between pilots and places his forehead on a set of fuse panels. At the bottom and center of the windshield is a white dot the size of a piece of confetti. When Velasco sees it line up with the X, he'll call the drop.

"Okay, steady, steady, steady," cautions Velasco.

The World Food Programme uses transports such as the L-100-30 (top) and the Ilyushin Il-76 (above) to deliver food to the troubled provinces of southern Sudan (opposite, top). For the Sudanese, life depends on the supplies dropped from the air (opposite).

"Check altitude and airspeed," says Gomez. "Just a bit to the left. Okay. Okay, steady, five seconds."

The ground is racing by. "I see the X," says Velasco. "Go! Go! Go!"

Bong slices the strap with a single swift motion. Sampson pulls the yoke back and pushes the throttle forward. Velasco sets the flaps at 40 degrees.

DAVID POVILAITIS

The Herc's nose pitches up, the eight-ton stick of corn rolls out the back with a roar, the airspeed slows to 132 mph, and the Herc climbs 100 feet. It's over in 2.5 seconds.

After dropping his second stick (during which, now eight tons lighter, the flaps will be set at 30 degrees), Sampson banks hard to the left and swoops over the zone. The bags, which break free of their pallets after leaving the airplane, lie scattered around the X. "Measure it with a micrometer and cut it with an ax!" shouts Sampson, giving Velasco a high five.

"I'd always thought of airdrops as a gentleman's sport," says Sampson, sucking on a warm Coke a few minutes later in the back of the Herc's big cockpit. Gomez is flying us the 400 nautical miles back to Loki and Bong whisks his switchblade back and forth on a sharpening steel like a pirate. "But we're flying 12 hours a day in a totally uncontrolled environment and I'm learning things from these guys that they never taught us in the Air Force." Things like how to change a blown tire in the field without a jack (drive the Herc up on a block of wood with the blown tire hanging off) and how to take off with one engine.

Sampson has been learning such tricks of the trade from guys like Charlie Kirkpatrick, 58, who has 15,000 hours in Hercs and nine years with the now-defunct Southern Air Transport, which had him logging miles over "South America, Central America, Asia, Africa, Alaska, Russia, and Japan—sorry I can't be more specific than that," he says. And then there's Bonzo, a tall, red-headed American who refuses to talk with anyone from the media except to confirm that, at 68 years old, he has over 23,000 hours of Herc time. Although Kenyan civil aviation regulations limit pilots to 105 hours a month, most Herc pilots are flying 200 to 300, with three months on and one month off. "This," Sampson says with a grin, "is getting the job done."

A decade ago, when Stewart first brought the U.N. to Loki, it was a quiet, inconsequential dirt airstrip in the middle of nowhere. Not anymore. As dusk makes the rugged brown mountains straddling its airstrip glow, Loki feels like Chicago's O'Hare on a Friday afternoon, with Hercs, Buffaloes, and Caravans roaring one after another onto the runway in a desperate race to beat the setting sun. Once on the ground they are attended by crews employing buckets and scrub brushes, rusty fuel tankers, and front-end loaders that stuff the Hercs' bellies full of corn for the next day's dawn rotation. Though paved now, Loki remains a daylight-only, visual-flight-rules airstrip with a single Kenyan controller, paid by the World Food Programme.

Relief flying, though, is, by its very nature, fluid, not given to the tight systems and controls that govern the rest of the aviation world. Airplanes are out there, and sometimes they can't get back by sunset. When that happens flares are lit along the first 1,500 feet of

The Cessna Caravan, piloted by Diana Layfield, is known for its forgiving qualities in the air. Even forgiving aircraft must make it back to Loki by sunset, since the airstrip is unlit (below).

the runway, and pilots have 20 minutes to find their way down before the flares burn out. They don't always make it. In August a Trackmark Caravan carrying four passengers was coming in after a long day, and the pilot, who had flown 11 stops in 12 hours, briefly nodded off, even with the flares in sight. The Caravan nosed into the ground, bounced, then missed the runway. Although the airplane was destroyed, only the pilot was injured. "It's exciting, challenging, and difficult flying," says David Machareia, the Kenyan pilot of a de Havilland Buffalo owned by a Canadian company under contract to the World Food Programme. "You can't afford to relax and you get addicted to it."

"There are so few rules and regulations that what keeps it all together is just people's experience," says WFP flight coordinator Rod Lodge, 43, a veteran of U.N. airlifts in Somalia, Rwanda, Belfast, Khartoum, and the Persian Gulf. It's Lodge who daily creates an orderly flight schedule out of the blizzard of requests for flights and food drops from all of the Operation Lifeline Sudan agencies. He works out of a pint-size desk in a spartan room adorned with a giant wall map of the Sudan, a computer, and a radio that never stops squawking. Short and round, with a big laugh and a pair of sagging green shorts, he confesses that "my C.V. looks like a war record. I don't think British Airways will ever hire me. Ha."

Lodge works seven days a week, and like most of the relief workers in this frantic, patchwork world, he usually ends the day at one of the bars in the various camps around the airstrip. Indeed, it's now 1 a.m. and Lodge is swaying to a Rolling Stones tune at the raucous "Loki Hilton"—a recurring B.Y.O.B. party in a cramped courtyard lit by a bare bulb at the International Committee of the Red Cross compound. "Unfortunately, the aid business is growing," he says, swigging a cold Tusker beer. "There are more and more people in the world and more and more wars. If you want to get a good snapshot of the world at the end of the 20th century, come to Loki. There's money, technology, poverty, war, and hunger. It's a wild place."

Part of Lodge's job is to assess the landing conditions and report them to pilots. None of the roughly 180 airstrips in southern Sudan are paved, some are mined, and for the last three months the region has been deluged with rain. Relief workers in the field, most of whom have little aviation experience, must radio in a morning weather and strip condition report for Lodge and the pilots. The monitors don't always get it right. The week before, a Trackmark Caravan hit a soft patch and nose-dived into the mud, resulting in bent propeller blades, which were soon replaced. "We try to be as careful as we can but this isn't Europe," shouts Lodge over the music. "It's a war zone and we're endeavoring to provide a service despite

weather and security problems. But sometimes Africa wins again."

While the Hercs move most of the tonnage, it's the Caravans and Buffaloes that move people, as well as goods, like cooking oil, that can't be dropped from the air. If you need to land, then the Buffs, as they're called at Loki, are perhaps the best suited for the job. Indeed, it's 3 p.m. and after a two-hour flight from Loki, Allen Paul, 45, is about to put 12,000 pounds of cooking oil, 200 pounds of water, and 800 pounds of cereals on a 1,700-foot dirt airstrip that's curved like a banana. "The Buffs were made to insert equipment into rough places like Vietnam," says Paul, a veteran of 4,500 hours of Buffalo flying with the Canadian air force. "If you can drive a jeep across a field at 35 miles an hour, you can land a Buff. It's got two 3,000-horsepower engines, a high, STOL [short takeoff and landing] wing, good brakes, and full reverse. I can put 39,000 pounds down in 500 feet."

A decade ago, while still in the air force, Paul asked for a year off without pay to fly in Africa. He didn't get it. Now he's flying for a Canadian company under contract to the World Food Programme. "I wanted to come to Africa and see how the Buff worked in a real environment, and now I know that these planes were almost built for the Sudan," he says.

We race low over the strip at Majakliet in the province of Bahr al Ghazal, bank around, and land. A swarm of impossibly tall women, naked from the waist up and decorated with beads around their necks and scars on their foreheads, attack the boxes of oil, stacking them 10 feet behind the airplane. A man nearly seven feet tall stands a foot from the ear-splitting auxiliary power unit, peering at it like someone trying to decipher a magician's sleight of hand. In 10 minutes the Buff's belly is empty and Paul and his Belgian copilot, Alex Gazze, are poised for takeoff. "Okay, watch," Paul says, standing on the brakes and throttling up. "The flaps are out and we're going to full power before we start to roll." With the Buff vibrating wildly but going nowhere, Paul releases the brakes. The Buff leaps forward and bounds into the air in 10 seconds. "Pretty good, eh?" says Paul, settling down for the flight back to Loki.

"I hope it starts this time," mumbles Eric Hallard, activating the starter of one of Trackmark's Cessna Grand Caravans. It's 9:30 a.m. and we're in Mapel, which is in the middle of Bahr al Ghazal—a two-hour flight from Loki. It's at least 100 degrees outside. Hallard is wearing shorts and a white short-sleeved shirt with gold captain's bars, but sweat is still pouring down his face. Tsetse flies the size of yellow jackets are careening around the cabin.

Mapel, with a relatively hard, 850-yard gravel airstrip, is the site of the U.N.'s first permanent camp inside the Sudan. Yesterday, after it dropped off a team of monitors there, the Caravan failed to start and another airplane stopped by and swept Hallard back to Loki to collect a mechanic before returning them to Mapel to fix the airplane. There's a whir and suddenly the turbine-powered Caravan jumps to life. Hallard slams the door shut. Outside a horde of sweating men, women, and

Relief pilots praise the Buffalo (right) for its ability to land on short runways. The runways in southern Sudan (opposite) are frequently soft and muddy, making landings and takeoffs potentially treacherous. The airstrips can also double as drop zones for grain, which barrels out of the sky in 110-pound bags (above).

children part, and we bump to the end of the brown strip, turn, and launch into the haze, bound for a village called Lankien one and a half hours away.

"This may not be the perfect airplane for out here, but it's close to it," says Hallard, climbing over a flat world of green. "I call it the stupid-proof airplane because it's so easy to fly and so forgiving. But we have to push it to the limit to get in and out of some of these strips. It's not a STOL airplane like the Twin Otter and its acceleration is poor. I wish it had more horsepower." (The only modifications the Caravans have for the Sudan are hardy bush tires.) "Fully loaded you need 600 to 700 meters of good runways, and if it's wet or sandy you get more drag and you have to reduce your load," continues Hallard, slipping off his shoes and tucking a bare foot under him. "Even if there's a bit of an overrun on the runways you can't use it—there are trees and bushes and huts and you'd better be in the air. But it's cheap, reliable, and comfortable."

Most of Hallard's days are like this one: a three-hour flight into the Sudan, then a full day of schlepping U.N. food monitors, relief workers, and everything from diesel fuel to tents to medicine from one airstrip to another. Tack on the flight back to Loki and he's working an 11-hour day with as many stops. Throughout he will be in constant radio contact with Trackmark's base in Loki, but his contact with life on the ground is minimal. The Herc airlift pilots never set foot on Sudanese soil, returning home each night to a swimming pool, satellite television, and cold beers behind barbed wire. And while the Caravan and Buffalo pilots do land, they stay just minutes, returning every evening to Loki.

At 11 a.m., as we descend into Lankien, Hallard slips his shoes back on and checks the "jungle Jepps," a spiral notebook with rough sketches of airstrips and listings of their altitudes, lengths, degrees of hardness, and obstructions or special considerations. "You really rely on other people here," he says, dropping at 500 feet per minute over a green carpet that seems ever unchanging. "If I have to fly to a place that I've never been, I ask other pilots what it's like and try to radio the monitors on the ground." At 500 feet, we blast over the 600-yard strip, a rutted brown gash between green grass and miles of flooded fields choked with water lilies. "There's no mountains out here," he says. "It's hard to hit anything, and the long stretches of flying can be boring, but when you go in you've got to get it right." He lines up for the approach.

Two malnourished children from the village of Akon fly back to Lokichokio for medical treatment.

We bump, jerk, and slide to a stop, a crowd gathering around the airplane. Flies bite and mosquitoes swarm. The heat is intense. Mud is splattered over the Caravan like a Jeep in a road rally. A couple of Sudanese People's Liberation Army soldiers in tattered fatigues watch from a distance. Dierdre, an Irish aid worker for Doctors Without Borders, emerges from the tall elephant grass, shoves a backpack into the Caravan's pod, and jumps in. "Any soft spots on the runway?" asks Hallard, firing up the Caravan and taxiing out.

"Yeah, the last 100 meters is wet on the right side," says Dierdre. We thread a puddle of water and swivel short of the end of the strip, then Hallard hits the throttle like there's an elephant charging our tail. We crash and bump over ruts, footprints, and the occasional bit of grass in the middle of the strip. Three minutes after landing we're up again, heading to a place called Leer, 60 miles and 30 minutes away.

"That wasn't bad," says Hallard, spraying a gaggle of flies in the cabin with insecticide. "Add some trees at the end, a full load, and a bit more water and it gets difficult."

For Dierdre, the flight to Leer is a trip into the unknown. "There's been no NGOs [non-governmental organizations] in Leer since June [four months ago], when a band of renegade rebels suddenly fought each other," she says. "There was a lot of flooding and fighting and so no new crop was planted. We hear people are hungry. We went in at the end of September but could only stay 10 minutes. Women and children were fleeing with stuff on their heads. Soldiers told us they were expecting trouble, so we left some medicine. They said 20 people a day were dying of fever. And today is the first time we're going back. Three of my colleagues went in this morning. But there's no radio there so we don't know what we'll find. We expect things to be bad."

Leer's strip is 3,300 feet long and 20 wide. Where huts used to stand, there are nothing but charred circles. The few buildings are roofless. Upon landing, the heat feels as heavy as a wet blanket. Naked children touch me and rub my hands in traditional Dinka greeting; an extremely tall man smoking a pipe and

wearing a tattered blue dress beats them back with a switch. The smell is overwhelming, the flies biting. Three aid workers emerge to fetch Dierdre. "We just got here ourselves and we don't know what the situation is yet," a Norwegian in a baseball cap says. "We'll have to do an assessment and then we'll know. But a lot of people seem sick."

Suddenly the crowd parts and a dozen Dinka stride up carrying wooden beds with ancient-looking cowhide-strip mattresses. Bare husks of people lie on them, utterly still, flies swarming around their mouths and their open, unblinking eyes. One is a girl, perhaps 12, curled in a fetal position and loosely covered in a soiled wool blanket, her knee a festering wound covered with flies. To me, she looks dead. Hallard jumps in the Caravan and radioes the International Committee of the Red Cross hospital at Loki. Moments later, drenched in sweat, he yells, "Okay, I can take the men but not the girl." There's a lot of shouting. "I can take three people, no more," he says. "I can't take the girl. I can't do it! Don't ask me why! Come on, come on."

The wounded men, presumably soldiers, are shoved onto the floor of the Caravan behind a single row of seats. Three more men, representatives of the Sudan Relief and Rehabilitation Association, the humanitarian wing of the Sudanese People's Liberation Army, jump in. The Norwegian scribbles a quick note—"Arrived safely; need our equipment on the next flight tomorrow"—and asks me to hand it to the head of U.N. operations in Loki. Leaving the girl to a certain death, we jump in and are quickly airborne on a flight to drop off our three passengers at Lankien before heading back to Loki, where we'll take the injured men to the hospital. "They are all gunshot victims," Hallard says, "but the ICRC [International Committee of the Red Cross] says we can't take children, only combatants." (Laurent Fellay, an ICRC spokesman in Geneva, says the mission of his organization is to treat all battlefield victims, including civilians, so Hallard may have misunderstood or had another reason for not flying the girl back to the ICRC surgical hospital in Loki.)

"Flying here you get accustomed to doing many things you would never do in Europe," says Hallard, filling in his logbook (when he took off today he went over the 105-hour limit). At 26 he's already accumulated more than 2,500 hours. "I got my license when I was 17 and at first it was slow, but now I'm busy, busy, busy," he says. "I don't know if I'll ever go back to Europe. Sudan is a huge country and Africa a huge continent and you can do what you want. Here you are free."

An hour later, we are weaving through big, puffy clouds at 10,000 feet, a cold wind pouring in through the vents and a perfect sliver of daylight moon at 11 o'clock. The heat and stench of Leer are another world. Suddenly, a fly lands on my neck. I turn around to swat it and spot the men, stick figures silent and still on the floor. "Look," says Hallard, pointing to the clouds as we slip through a valley of white. "It's like flying between the mountains, eh?" He props a bare foot on the dashboard, connects our headsets to his Walkman tape recorder, and pours himself a cup of coffee from a thermos. "I love flying in Africa," he says.

A Douglas DC-4 owned by a charter company that lost its relief-work contract sits abandoned among the thick grass of Lokichokio.

Where America's foremost space center now stands once stood Artesia, and Nathan, and downtown Stinkmore.

by Gary Harris

Illustrations by Ken Dallison

Within a stone's throw of Atlas launch complex 36, our little party waded single file through dense scrub that likely hadn't seen a human visitor in decades. Roger McCormick took the lead. He had on the heaviest boots and would, in our wishful logic, be the first to blunder over any rattlesnakes, wild boars, or bobcats for which this part of Cape Canaveral is famous.

Sweating, tripping, swatting mosquitoes, and cursing the heat, we stopped every few minutes to let Walter Newquist, who was in his late 70s, get his breath and his bearings. Walter was one of the few remaining witnesses to the first rocket launch from Cape Canaveral, Florida, nearly half a century ago. He was also about 35 years older than the rest of us. As he tried to pick out familiar landmarks in the overgrown brush, he slowly shook his head.

A former Air Force technical sergeant with the 2770 Standby Squadron, Newquist had been one of the first 40 enlisted men assigned in the late 1940s to the Joint Long Range Proving Ground—later the Eastern Test Range—at Cape Canaveral. Each time I looked back to see how he was doing, he straightened noticeably: again the steely-eyed missileman.

Up ahead, Roger, who in his day job is a space shuttle tile technician, stopped and said, "This is it." We stood in a clearing not more than two yards on a side. Brushing back the overgrowth, it was obvious we were standing on concrete. I took out my pocketknife and began to feel out the square shape; it was about 20 feet on a side and four inches deep. Shards of glass from a mirror and finger-size pieces of wood lay strewn among the vegetation. I broke off a piece of concrete the size of a quarter, and Walter bent down next to me. "This must be the floor of the tar paper shack blockhouse," he said. "It lay 500 feet due north of the V-2 missile. I was last here in the summer of 1950."

Our small band of volunteers from the Air Force Space and Missile Museum on Cape Canaveral paused for a moment of satisfaction. Through our own research, interviews all over the state, investigations into photo archives, and plain luck, we had found what was left of the quasi-secret and mostly forgotten Project Bumper.

Bumper was part of the Army's Hermes rocket research program, during which German and U.S. engineers launched modified V-2 missiles captured from Germany at the end of World War II. Between 1946 and 1952, more than 60 V-2s were launched from the White Sands Proving Grounds in New Mexico. Another was launched from a ship at sea. And two were launched from Cape Canaveral.

In 1948 the Army began high-altitude shots under Project Bumper, which mated V-2s to smaller WAC Corporal rockets (one source has the acronym standing for "Without Any Control"). These hybrid vehicles, the world's first liquid-fuel two-stage rockets, eventually reached as high as 248 miles, a record that stood until 1957.

With the missiles flying ever higher and farther, the 100-mile-long test range at White Sands began to feel cramped. The problem became painfully clear in May 1947 when a V-2 veered off its intended path and arced south over the city of El Paso, landing near the outskirts of Juarez, Mexico. Though no one was killed or injured, the missile blasted a crater 30 feet deep and 50 feet wide near Tepeyac Cemetery. To avoid an international incident, the U.S. government quickly offered financial resti-

The Year the Rockets Came

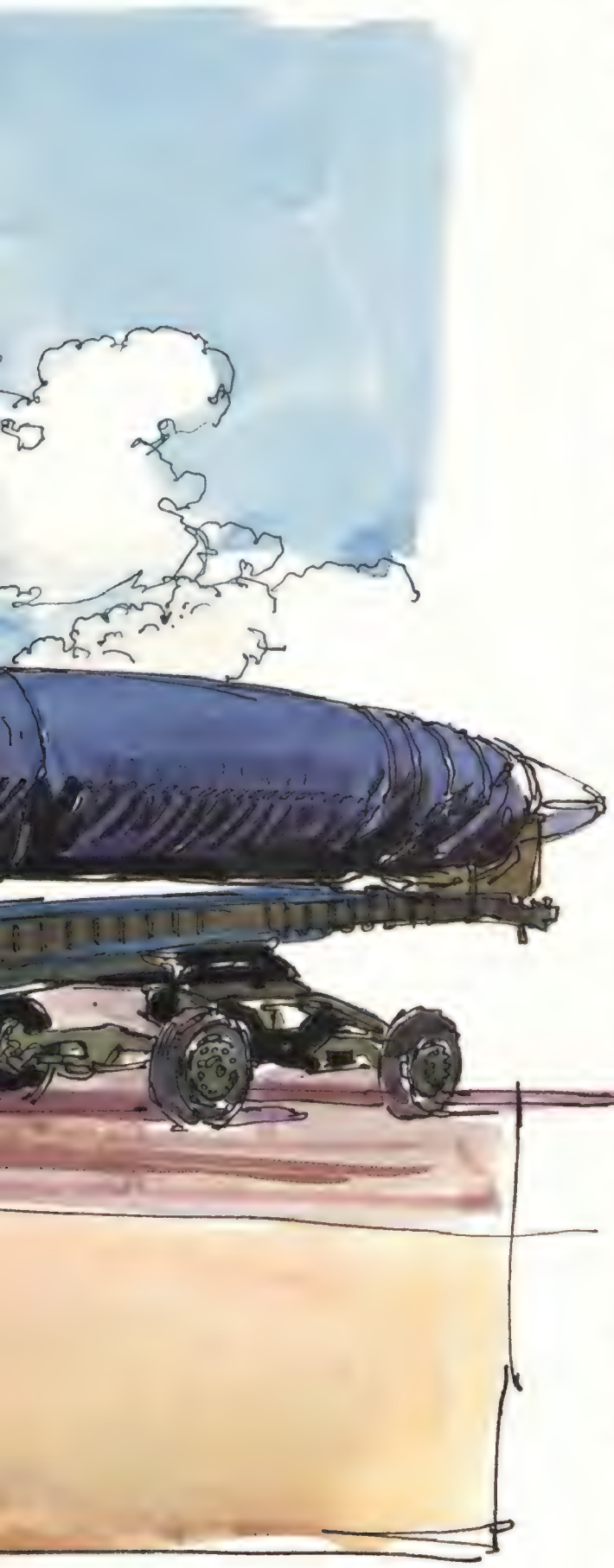
tution. One elderly Mexican claimant sought compensation, stating that the explosion had so frightened his wife she had been left "sexually frigid." When told he would have to make a written statement of all circumstances, he opted for $250 in cash instead.

Even before that, the Joint Chiefs of Staff recognized the need for a permanent test site for long-distance missiles. In October 1946 a committee was formed to develop a Joint Long Range Proving Ground (JLRPG)—a place where the Army, Air Force, and Navy could all fire their missiles with impunity.

A launch site in Washington state, with tracking facilities in the Aleutian Islands, was rejected because of the climate. Two California locations, Point Mugu and Inyokern, were considered, but their ranges were limited to about 150 miles and couldn't easily be lengthened. The committee's first choice was near the El Centro Naval Air Station, just north of the Gulf of California. The weather was good, and the site would have allowed missiles to be launched to the east over Mexico and to the south over the gulf. But the president of Mexico, no doubt still mindful of the Tepeyac Cemetery incident, refused to allow U.S.-owned tracking facilities in his country.

That left the second choice, a barren jut of land called Cape Canaveral, located halfway down Florida's east coast just north of the Banana River Naval Air Station (now Patrick Air Force Base). The Coast Guard already owned some of the land, and the rest could be bought cheap. The site had generally temperate weather, adequate roads, and railroad access. It was close to the equator, which meant that rockets fired to the east (over an ocean—another plus)

would get a bigger boost from Earth's rotation. And a convenient string of islands extended nearly 5,000 miles into the Atlantic, which gave plenty of options for placing tracking and radar facilities. When the British government granted permission for a downrange tracking station in the Bahamas, the decision was made. On May 11, 1949, President Harry Truman signed Public Law 60, creating the JLRPG at Cape Canaveral. The range was to be operated jointly by the Army, Navy, and Air Force, with the Air Force Chief of Staff having executive control.



Intentionally or not, the committee had picked a spot long associated with exploration. Records show that Europeans came to the Cape as early as 1513, when Ponce de Leon is believed to have anchored nearby. Originally it was called "Cape of Currents," but somehow the name became "Canaveral," which translates roughly to "Point of Canes," one of the oldest European place names in the United States. No sugar cane has ever grown on the Cape, but a type of bamboo reed called "Nomal Cane" by old-time residents still grows on the dunes near old Saturn Launch Complex 37. From offshore, bamboo looks a lot like sugar cane.

Scotch-Irish settlers came to the Cape in the 1840s and lived mostly isolated from the mainland for the next century. Before the missiles came, not much of note happened. Around 1870 a ship sank offshore with a load of shoes, and for years Cape natives could be identified by their non-matching footwear. The region's Spanish settlers had left behind a small but tough breed of cattle that thrived on the Cape's scrub and edible cabbage palm, and these were occasionally herded together, driven off the Cape, and—to the agitation of mainlanders—marched down the main streets of towns like Cocoa to the nearest railroad terminal to be sold. By some accounts, these cattle drives went on into the early 1940s.

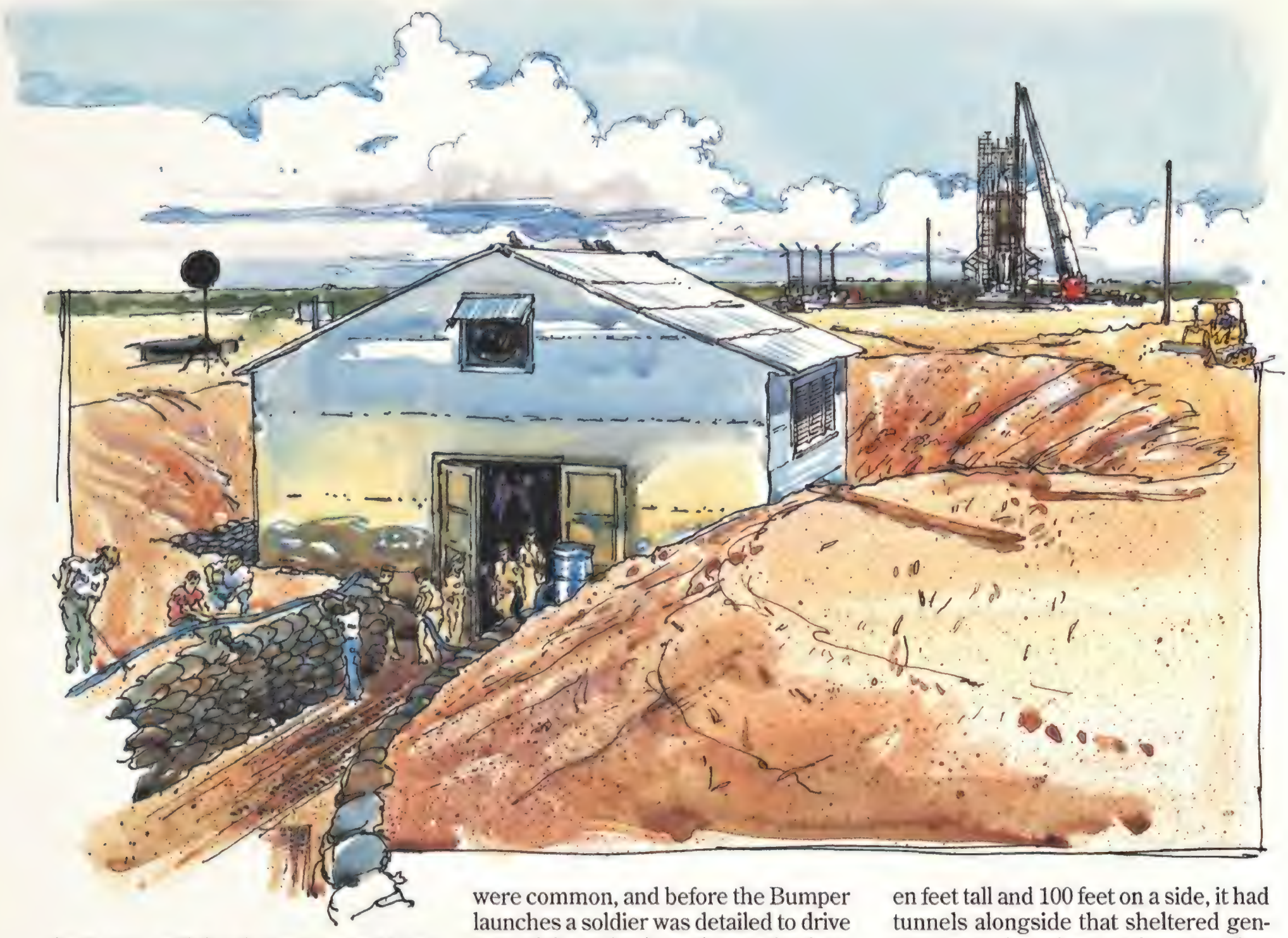
Earnest Jandreau, who now lives on the mainland near the city of Cape Canaveral, remembers how leery the old-time Cape residents were of newcomers. Jandreau's parents moved there in 1918, and he was born in the tiny hamlet of Artesia four years later. Each time Jandreau's mother went to visit the neighbors, who were Cape Canaveral natives, their three teenage daughters always "shinnied up an oak tree and remained silently hidden among the limbs" until she left. Jandreau says, "You must remember that in those days there were no roads on the island, and it was an all-day trip just to get off the Cape to go to the mainland."

For decades only the occasional sport fisherman ventured on the Cape's beaches. Then came World War II. It was rumored that German submarine crews sometimes landed in rubber boats on the Cape and walked inland to get fresh water. After the war, the newly established Banana River Naval Air Station would house a small contingent of German prisoners.

But it was the cold war, with its race to develop ballistic missiles, that brought lasting change to the area. By July 1950 the workforce building the newly approved launch range had swelled to 1,186 people, about half of them civilians. Even before their work was finished, Bumper project managers decided to try something they couldn't do at the smaller White Sands range, which was to ignite the second-stage WAC Corporal while it was traveling downrange at a low angle to the horizon, the way a bomb-carrying missile might. So the Army bulldozed a road through the swamp, poured a concrete launch pad, set up a tar paper shack "launch center" not far from the pad, and fired two rockets from Cape Canaveral.

That's the way the official histories tell it. But the Cape wasn't entirely unpopulated, and some of the hardy, contentious locals were of no mind to be removed from their land. When the government intruders came, as many as a hundred residents were scattered among various farms and four villages: Artesia (later incorporated into Port Canaveral); the town of Nathan just north of what is now shuttle launch pad 39B (an area then called Titusville Beach); a fishing settlement and pier that the locals called "Stinkmore"; and a relatively prosperous collection of structures occasionally referred to as Cape Canaveral, or sometimes Canaveral Beaches (near today's Atlas pads 36A and -B). The latter hamlet, just north of the Bumper site, had as many as 15 homes, a store, a brothel complete with mirrored walls and ceilings, and a small hotel where some of the Air Force people stayed.

According to Walter Newquist and 80-year-old Norris Gray, a retired fire chief and long-time Cape fixture, at least two dozen people still lived near the Bumper complex in the summer of 1950. When it came time to launch the rockets, soldiers would pile the residents onto trucks and into buses and move them to the old Brevard Hotel in near-



by Cocoa until the shot was over. Many refused to leave. Gray remembers accompanying a squad from the 11th Airborne to persuade his neighbor, Mona Martin, to leave her premises. When the elderly woman ran out on her porch with shotgun raised, the elite troops scattered like quail, leaving the fire chief looking down both barrels. Gray, though, knew the barrels were plugged with wood, and that Martin, who lived like a hermit, was actually wealthy enough to have moved her entire house from England. "Mona, you don't want to shoot me," he recalls saying as he reached up to take her weapon. He slung her over his shoulder and carried her, still protesting, to the bus.

Unfortunately for the Bumper crews, the Cape's nonhuman residents—snakes, mosquitoes, and other vermin—were there to stay. Soldiers from the Third Infantry, who provided security for the launches, recall that they could press a hand against their mosquito netting and watch a hand-shaped swarm of insects form on the other side. Rattlesnakes were common, and before the Bumper launches a soldier was detailed to drive around the pad to keep the reptiles from sunning themselves on the warm concrete. At night the soldiers kept fire extinguishers in their tents to drive the snakes away. This worked for alligators too. One gator that lived in a nearby swimming pond was chilled to the point of immobility when super-cold liquid oxygen—leftover oxidizer from the V-2—was dumped into the water.

The Bumper launch pad points 28 degrees south of true east/west, right down the "alley" of the Atlantic Missile Range. Although it was built for the V-2, the Cape's first launch pad ended up being one of its most versatile. Bumper was followed by Bomarc, a surface-to-air missile; X-17, used to test reentry nose cones; Matador, an early cruise missile; and Lark, an early anti-aircraft missile.

Histories of Bumper call the concrete pad makeshift, but our survey of the site, along with archival photos and interviews with project veterans, suggests that it was rather sophisticated. A compartmentalized concrete box about seven feet tall and 100 feet on a side, it had tunnels alongside that sheltered generators and equipment for capturing fuel runoff. Access hatches placed at intervals around the pad allowed crewmen to lay monitoring gear and cables under the rocket. The umbilical tower—actually a pine telephone pole—for holding electrical and telemetry cables was set down in one of these hatches.

The pad had a water deluge system, which was used to wash away spilled propellants, dampen vibrations, cool the pad, and, if necessary, suppress fires. The water was pumped from three places: the Cape lighthouse about three quarters of a mile away, a nearby well, and the aforementioned swimming pond. The use of the deluge system accounts for the appearance of smoke rising from the pad during Bumper launches. The V-2 engine actually used clean-burning alcohol—the dramatic clouds were steam.

Even though it was a tar paper shack, the launch crew's blockhouse wasn't as primitive as some of the histories imply. The shack had been moved from a nearby location, where it had been used by local swimmers for changing

into bathing suits. Shortly after being moved to the Bumper site, it was covered on the top and sides with new, light-colored composite tar paper. A concrete floor was poured, and a ventilation system and periscope were added. Pieces of the periscope's mirrors have been found near the concrete foundation and even in small animal burrows several yards away.

The periscope was needed to see over a large berm—5,000 sand bags covered by many more layers of sand—protecting the shack. Photographers stood on the berm during the first Bumper launch. Even though the Army kept the test's weapons-related purpose secret, journalists were invited to film the firings. Mercer Livermore, an elderly local radio personality who was briefed before the launch, claimed this was meant to allay the fears of residents.

Although the Army was the primary sponsor of the two Bumper shots from Canaveral, other branches of the military and government were also involved. The Coast Guard furnished land and facilities. The Air Force provided picket boats and aircraft for security and to help keep commercial ships away from the impact areas. The Navy stationed a destroyer, the USS *Sarsfield*, and its escort, the USS *Foss*, downrange for radar tracking, telemetry recording, and range clearance. Even British military personnel got in on the act as observers and liaisons, since Bumper was to fly over the Bahamas. Several eyewitnesses, including Norris Gray, also remember that the Army's rocket heavyweights, Wernher von Braun and Kurt Debus (who later headed NASA's Kennedy Space Center), attended the launch of Bumper 8, although historians make no mention of them being present.

On June 18, 1950, an Army convoy carrying Bumpers 7 and 8, plus support gear, arrived at Patrick Air Force Base from White Sands. The same day, the WAC Corporal upper stage arrived via aircraft from California. Two days later the launch pad was completed and the painter's scaffolding that made up the rocket's 55-foot-high service structure had been erected and tested.

By July 5 the missiles had been checked out and the range safety officer was reporting "ready." Over the next week more engineers arrived from White Sands to set up communications, optical tracking, and telemetry equipment. That was followed by three practice launches, one of which had to be postponed when a rattlesnake claimed squatter's rights in a corner of the blockhouse.

On July 17, with the big event two days away, Bumper 7 was transported by Meilerwagen, a type of German transporter-erector, to the pad. On July 19, around 100 invited newsmen showed up, while local curiosity seekers brought picnic lunches to the pier and the beach around Stinkmore to take in the show.

They left disappointed. One delay after another kept the rocket on its launch pad. During fueling the WAC's highly corrosive red fuming nitric acid spilled down the side of the rocket and onto the pad (the damage to the concrete is still visible). That resulted in a time-consuming reinspection of the vehicle. Then the circuits that activated the WAC's body-mounted spin rockets failed. These solid propellant motors were meant to fire after separation from the V-2 booster to set the WAC spinning like a bullet, which would cause it to fly straight in the upper atmosphere. The launch team decided to go without them.

At 6:19 p.m. that day, Bumper launch director Leo "Pappy" White finally issued the command to fire, and the blockhouse crew hunkered down in anticipation of the shock wave. The Third Infantry Division soldiers braced themselves in narrow trenches just outside. A red glow appeared at the base of the rocket nozzle. The V-2 engine rapidly built up to its initial thrust level of eight tons, and then, after two seconds...sputtered and quit. Gray, the fire chief, was ordered outside to "safe" the missile.

They might have known it wouldn't go off. Pappy White's dog, Nippy, hadn't been in the blockhouse. White, who worked for General Electric, the Hermes prime contractor, was in the habit of taking the dog along wherever he went, and for most shots she was parked under the launch console at his feet. Early missile crews were a superstitious lot, and they'd noticed that whenever Nippy was around at White Sands, the Bumpers worked fine, but when she wasn't, they didn't. Sure enough, when Bumper 7 fizzled, she had been outside playing with news reporters.

The more immediate cause of the

abort, however, was a valve that had frozen stuck due to condensation. On the V-2, the fuel valve was only inches from the oxidizer valve, and the Florida humidity acting on supercold liquid oxygen over the course of several hours of delays had caused the problem. The *Florida Times Union* summed up the day's events in its July 20 edition: "Just about everything that could go wrong with the first experiment in low-angled firing of a guided missile did. When they finally got around to pulling the firing switch on the giant device it produced only a popping noise, hardly worthy of a champagne cork."

Reluctantly the ground crew took down Bumper 7 and replaced it with Bumper 8, vowing to load the oxidizer closer to launch this time and to make sure Nippy remained in the blockhouse. By July 24 all systems were ready for another try. At 9:28 on a Monday morning, Bumper 8's engine spewed flames across the pad, and the rocket age dawned over Cape Canaveral.

Norris Gray was standing in the back of the blockhouse at that historic moment. He had been an artilleryman with the Ninth Infantry in the Battle of the Bulge, and had watched V-1 Buzz Bombs pass overhead. He'd also seen contrails from V-2s bound for London. "I was worried that if the V-2 blew at any height of more than 10 feet above the launch pad, the sandbag berm would not protect us from the blast of the [self-igniting] fuels in the WAC rocket," he says. "At that height all that was between us and the rocket was 500 feet and some thin tar paper."

To everyone's relief, Bumper 8 rose swiftly from the pad. The rumble from the engine was faint at first, then rolled in waves along the scrub and reverberated off the low clouds. The shack rattled as if it were about to collapse. Gray watched mesmerized through the periscope until the missile rose above its field of view. When he broke his gaze and looked around the blockhouse, Gray found everyone else, who perhaps understood the situation better, "squatting on the floor as if a bomb was about to explode." As a result, he was the first to run outside to watch the show. As the missile reached the low cloud cover, the spectacular orange exhaust cast an otherworldly glow on the thin layer of cirrus.

Then things started to go sour. Within seconds the preset pitch controls had started the missile downrange, but the programming of the pitch had been excessive. The vehicle was supposed to be flying at an angle of 20 degrees relative to the horizon, but it was climbing at only 13 degrees. About a minute into the flight, at an altitude of 51,000 feet, the WAC Corporal separated from the V-2. The spin rockets ignited, but telemetry showed that the upper stage wasn't accelerating, presumably (engineers deduced later) because both booster and WAC were breaking up. When the V-2 dropped back down to 20,000 feet, the range safety officer detonated the missile. It fell into the Atlantic 48 miles downrange. It was never determined how far the WAC flew, because the data stopped flowing in mid-flight.

Afterward the launch crew didn't feel much like celebrating the partial success. Bob Haviland, General Electric's project engineer, remembers, "We were too tired to celebrate. We just went back to the hotel and slept."

Looking over the data later, the engineers determined that the structural failure had occurred at the point where the WAC and V-2 stages met. For the next attempt, they beefed up the junction. At 6:44 a.m. on July 29, Bumper 7 lifted off its launch pad. Once again the climb angle was too shallow. This time, though, the WAC's main engine burned for 103 seconds after separation, the second stage reached a velocity of 3,270 mph (still less than hoped for), and the telemetry kept up throughout the entire flight. To make the rocket segments easier to locate, engineers put green dye packs in both stages. Within three minutes of the time the V-2 hit the water, the WAC's dye marker was located, 150 miles downrange.

So ended Project Bumper. Although neither of the Florida shots had been

entirely successful, the program had demonstrated the concept of multi-staging, and had shown that the speed of a rocket could be increased with each successive stage. Satisfied with their accomplishment, the crews packed up and left. Most were delighted to see Cape Canaveral receding in their rearview mirrors. It would be nearly three years before another ballistic missile, an Army Redstone, would ascend from the Cape, but the future of the place was already plain to see.

Today more than 40 launch complexes sprawl over the approximately 25 square miles of the Air Force's Eastern Test Range on Cape Canaveral. Most are abandoned, while some, like the Atlas pad near the old Bumper site, are still busy launching commercial and government payloads. NASA's Kennedy Space Center, with its two space shuttle launch pads, is actually on Merritt Island to the north. The space agency built its moonport there after launching the Mercury, Gemini, and first Apollo missions from the Cape. Even today, the whole area is often erroneously referred to as "Cape Canaveral."

After selling their land to the government, the original Cape residents scattered to the winds. Mona Martin reluctantly moved to Orlando and reportedly lived to see humans travel in space. After growing up, some of the local children stayed on to work on the space program. Earnest Jandreau, for example, worked as a rocket propellant specialist for 30 years before retiring. His parents are buried on the Cape, in a small cemetery in the median of the General Phillips Parkway, about two miles north of the main gate at Cape Canaveral Air Station.

A total of seven tiny, scattered cemeteries are all that endure of the Cape Canaveral area's pioneers. Today the Air Force has given permanent security badges to their descendants so they may tend the grave sites. As the years pass, fewer graves have flowers placed on them, and the headstones are less lovingly tended.

Our own investigations into the long-forgotten Bumper location continue, and we hope some day to carry out a proper archaeological cataloging of the site. Meanwhile, the hunt for veterans of the Cape's first rocket launches goes on. A 50th anniversary celebration is planned for July 24 of next year. The reunion will be held at the Bumper site, the Kitty Hawk of the space age, where it all began.

COMMENTARY:

A New Carrier—How We'll Get There

The end of the cold war has not diminished the need for aircraft carriers. Admiral Jay Johnson, chief of naval operations, recently noted, "Since 1990, the U.S. carrier force has been as heavily involved, if not more, in responding to and deterring global crises." During the cold war, the Navy participated in one crisis-response operation about every 11 weeks. Since then, the rate has increased to about one every four weeks. Carriers provide the unique ability to position forces well ahead of a crisis, project power, and remain long after the dust settles. Combat commanders demand naval presence to fulfill their missions, and the ship they demand most is the carrier.

As floating cities with a population of some 5,000, carriers provide offshore air bases that are virtually immune to the political limitations of land bases. But their size, manpower requirements, and complexity necessitate a large investment of national resources to acquire and operate. The Navy is focused intensely on how to meet national security objectives and how the future carrier will be designed. The 21st century carrier strategy represents a new era for these vessels, and the Navy is navigating a true course to the future with a steady hand on the rudder.

The Navy envisions a completely new class of vessels under the general designation "CVX," the "X" signifying the infusion of new technology. The strategic objectives of the CVX concept include improved combat capability and survivability at a lower total cost of ownership. The Navy is equally committed to sustaining the number of carriers dictated by our national strategy, and the current acquisition plan achieves a balance between risk and prudence.

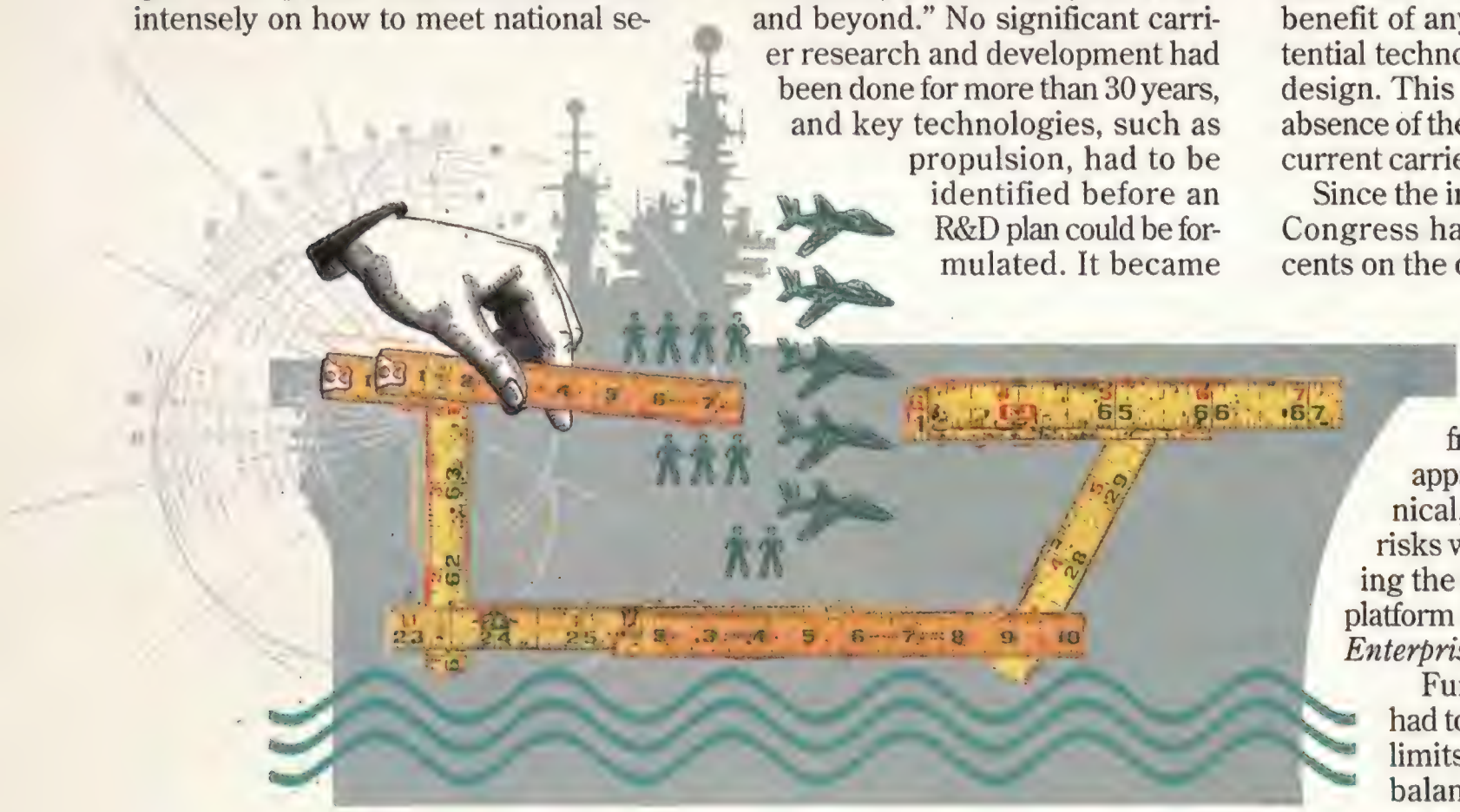
The roots of CVX can be found in the force structure review that took place shortly after the beginning of the Clinton administration in 1993. This Bottom Up Review directed the Navy to evaluate "a full range of sea-based platforms to project air power and meet our military needs in the period 2020 and beyond." No significant carrier research and development had been done for more than 30 years, and key technologies, such as propulsion, had to be identified before an R&D plan could be formulated. It became clear that a new class of aircraft carrier would not be achievable in the near future at a reasonable cost. The Navy had to devise a research, development, and acquisition plan to provide a range of real options according to a two-track strategy.

The long-term track (the CVX program) called for an all-new ship design by 2006 to replace the carrier *Enterprise* (CVN 65), one of eight nuclear-powered carriers, by the year 2013. The *Enterprise* will have served for 52 years, and her nuclear fuel will be depleted. The near-term track envisioned building a final Nimitz-class carrier, CVN 77, to replace an oil-fired Kitty Hawk-class carrier. CVN 77 would incorporate technologies that enhance the capabilities of the Nimitz class and serve as a first step in the transition to CVX.

The CVX program was formally initiated in 1996 with a Mission Needs Statement that listed the requirements for the 21st century carrier. A robust R&D effort was proposed without the benefit of any in-depth studies of potential technologies or aircraft carrier design. This was complicated by the absence of the original designers of our current carriers, who retired long ago.

Since the inception of this program, Congress has funded only about 50 cents on the dollar, and as this limited effort proceeded to capture and identify the costs and requirements of an all-new design from the keel up, it became apparent that significant technical, financial, and schedule risks would be incurred in making the leap to a completely new platform in time to replace the USS *Enterprise* by 2013.

Funding of new vessels also had to be considered within the limits set by law. Prior to the balanced budget agreement,



DAVID POVILAITIS

Rear Admiral Ronald L. Christenson of the U.S. Navy defends a step-by-step approach.

carriers were "national assets," normally funded over and above the Navy's budget by Congress. Now they had to be funded from within the Navy's shrinking recapitalization budget. As good stewards of the taxpayers' assets, and after weighing the tradeoffs and the risks, the Navy wisely chose a phased approach that assures its ability to continue to meet national strategic requirements without breaching spending limits. CVX became CVNX when the September 1998 Defense Acquisition Board validated the phased approach strategy and approved nuclear power as the propulsion source. The propulsion decision is key and creates the longest lead times.

This phased approach is based on the realization that the only way to achieve the goals for CVNX is to redesign the vessel's interior arrangements and distributed systems. And the only way to do that is to divide the entire task into manageable "bites" that eventually result in a total redesign and an all-new ship.

CVN 77 is the first phase of the carrier strategy and will be the Navy's transition ship in three major areas: technology, processes, and business practices. It will differ from today's carriers by having a fully integrated combat system, including weapons, command and control, surveillance data collection and dissemination, and aviation electronics. This combat system will offer lower direct ownership cost and manpower requirements along with major improvements in warfighting through data exchange, enhanced strategic and tactical decision-making, an upgraded defense against anti-ship cruise missiles, and displays for the operators. Carriers are already the most survivable ships afloat. These new systems will further enhance their survivability by reducing the chances that they will be hit in the first place.

The transition to new processes is equally important, and the Navy is working with the shipbuilder to adapt more commercial practices that employ computers to ease and speed the design process. This step is critical to achieving the carrier strategy goals but will have to be incorporated carefully; to take on the entire design task in one step presents an unacceptable risk. One example of a bite that is relatively easy to digest is a newly designed island with an integrated combat system, which may be ready for CVN 77.

The Navy's 21st century carrier strategy represents a new era for these vessels.

The third transition area is in business practices. While these are difficult to explain in detail, the short version is that the Navy and the shipbuilder are working together to take costs out of the ship through the use of new contracting methods, commercial technologies and processes, and system integrators. This Integrated Process, Product, and Design concept has been successful in other industries and has reduced costly changes that occurred during the construction phase.

The next step will be CVNX 1, which will incorporate all these digestible bites and add an extremely critical block in the phased approach: a new propulsion plant and electrical power generation and distribution system, which will provide improved survivability, operational availability, and electrical capacity. In the future, the demand for electricity will only grow, as it will be needed to power such systems as a new electromagnetic catapult that promises significant operational advantages and savings over steam catapults while reducing topside weight and maintenance.

CVNX 2 is the third step of the phased approach strategy. With the systems from CVNX 1 now proven, this next ship will be ready to accept emerging technologies that will provide greater design and operational flexibility, greater reliability, and reduced life cycle cost. With the Nimitz hull approaching its limits, the Navy will assess either modifying it with a major internal redesign or designing a completely new hull form.

As the Navy takes steps to reduce carrier costs, what must be foremost in everyone's mind is that this is not an investment in the bond market. The return on investment will be determined by the war-fighting capabilities of this ship over its 50-year service life, not only those that are uniquely naval but also those that will work in future operations with the other armed services.

Recent world events illuminate the importance of the aircraft carrier and the truth of the bumper sticker that describes the vessel as "4 1/2 acres of United States sovereignty." Carriers will continue to have a major role in U.S. national strategy, thanks to prudent risk management and good stewardship. Rather than watching the sunset, what we are witnessing is a new dawn for the centerpiece of the Navy's—and arguably America's—national security strategy: the aircraft carrier.

Rear Admiral Christenson is currently serving as Head, Carrier Programs Branch and Aviation Manpower and Training Branch. He graduated from the U.S. Naval Academy in 1969 and was designated a naval aviator in 1971. After serving as commanding officer of the USS *Theodore Roosevelt*, he was selected for flag rank.

GUIDING LIGHT

When the decision was made to take the war into North Vietnam, in order to punish and encumber that government's support of revolution in the south, U.S. military planners drew up a list of targets to bomb—rail yards, air bases, bridges, supply and ammunition stockpiles, radar sites, barracks, power plants—94 sites altogether, approved by the Joint Chiefs of Staff on April 17, 1964. The 14th target on the list was the Than Hoa rail and highway bridge, spanning the Song Ma River 70 miles south of Hanoi. All military supplies sent from Hanoi into South Vietnam crossed the Than Hoa bridge.

The Air Force hit the bridge on April 3, 1965, with 69 aircraft, all of them exposed to concentrated, capable defenses. The attack aircraft, 46 F-105 Thunderchiefs, or Thuds, from the 67th Tactical Fighter Squadron, based in Thailand, carried either 250-pound Bullpup radio-guided missiles or 750-pound conventional bombs. Neither did much damage to the bridge. Most of the bombs simply missed, and the Bullpup missiles, though more accurate, "bounced off," as one F-105 pilot described it after returning to base. So the 67th went back the following day—minus the Bullpups. They dropped hundreds of bombs in the two attacks. Two Thud pilots, shot down by MiG-17s, died in the second strike, a third spent the next seven years as a prisoner in Hanoi, and still the bridge stood. It would take a team of Texas Instruments engineers, a laser light scientist in Alabama, and a headstrong Air Force colonel in Florida to create the weapon that would finally drop the Than Hoa bridge, but not before another 869 missions were flown against it and 11 aircraft were destroyed trying to take it out.

U.S. AIR FORCE

In a dramatic demonstration of accuracy, a Paveway II laser-guided bomb finds its target during a 1975 test at Eglin Air Force Base in Florida. North American Aviation was one of several companies experimenting with lasers in the 1960s for use in guided weapons (opposite).

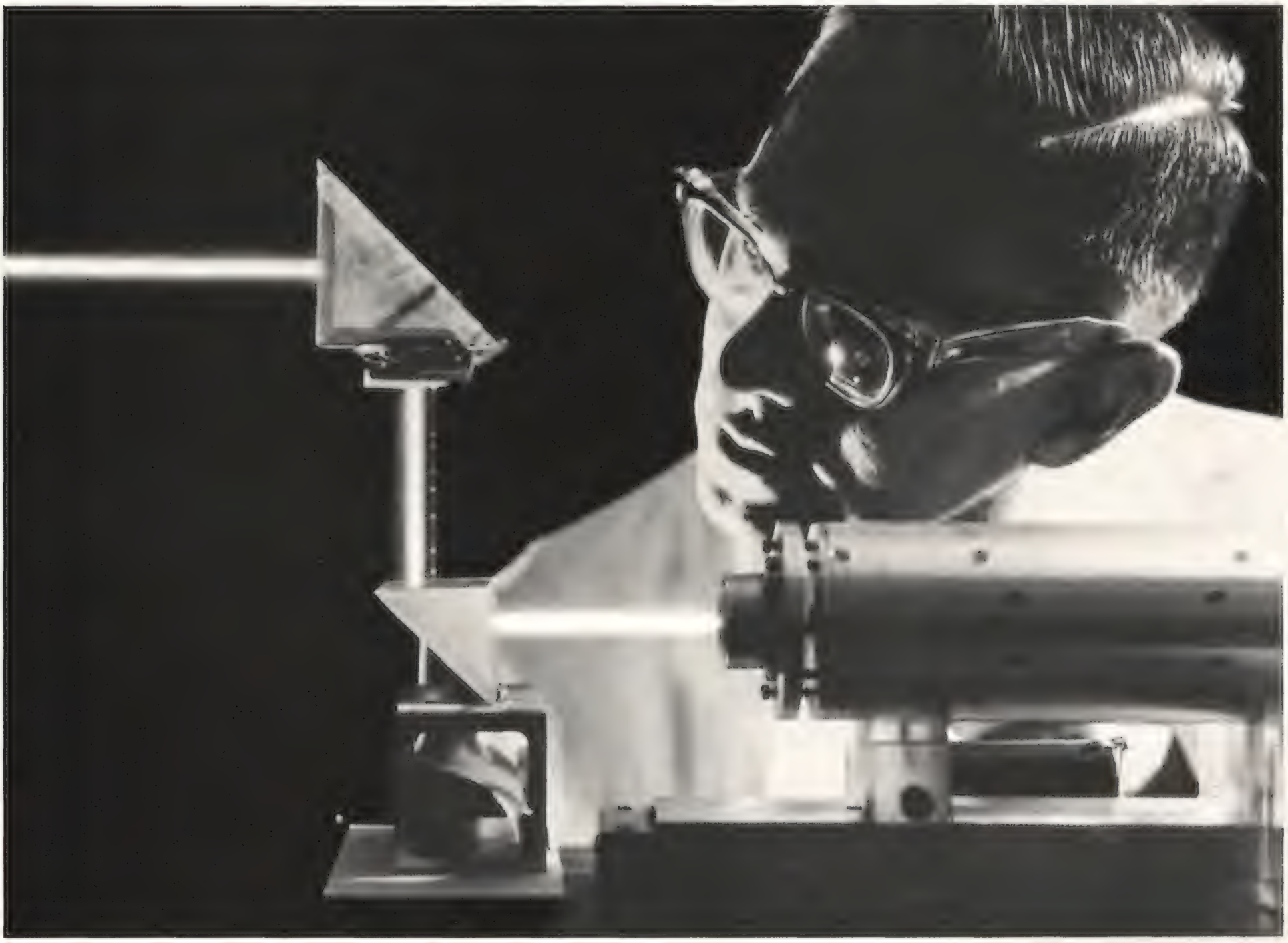
At about the same time U.S. strategists were refining their list of targets in North Vietnam, Colonel Joe Davis Jr. was watching the demonstration of a laser "gun" at the Glenn L. Martin Company in Orlando, Florida. Davis was the commander of a detachment that had been created at Florida's Eglin Air Force Base to hunt down technology that could bring immediate improvements to air combat in Vietnam. Martin representatives showed him everything they had, but what Davis remembered was the laser, which was inspired by the work of civilian engineers at the U.S. Army Missile Command in Huntsville, Alabama. Since about 1960, David J. Salonimer and Norman Bell had been experimenting at Huntsville with a laser guidance system for anti-tank artillery. To the conservative military culture around Huntsville, lasers still had an aura of science fiction about them, and the first enemy tanks wouldn't arrive in Vietnam until 1972, so the Army's interest in the project during the 1960s was slight. But Davis was impressed.

"Dave [Salonimer] had conceived this idea of the Army artillery using a laser," says Weldon Word, then a Texas Instruments engineer who eventually led the program to develop a laser-guided bomb. Word had been working on a submarine detection net off the New England coast and was looking for a more challenging project when he crossed paths with Salonimer in late 1964. "Well, Salonimer thought: Wouldn't it be great if you could take a flashlight, à la a laser, mark a target, and then send a missile or a shell or whatever over the hill and hit it," says Word. "Those were the serious early thoughts about laser guidance."

Salonimer got TI a small amount of money for a concept study to transform the Shrike anti-radar missile, which the company was manufacturing for the Navy, into a ground-launched, laser-guided rocket. Converting a missile designed to be launched from an aircraft already flying at Mach 1 into one that would shoot off the ground from a rail turned out to be not a great idea, and the Shrike itself had problems in the field. But it had a seeker-and-control system that was being used to home in on electromagnetic signals in the radio portion of the spectrum. Why not, thought Salonimer, send it reflected light?

Denied targets in Vietnam were suddenly vulnerable when the Air Force got its first laser-guided bomb.

by Shelby G. Spires



UPI/CORBIS-BETTMANN

"We didn't know a thing about lasers," says Word. "We listened to Dave."

Unlike a flashlight, which spreads its light out pretty quickly, a laser emits a narrow, pencil-like beam that stays tight over a long distance. And its light shines in a single wavelength, so a receiver sensitive to energy in that wavelength will ignore potentially confusing light sources, like fires and flares. What Salonimer was asking Word and the TI gang to invent was a detector that could see the reflected laser energy, much as the Shrike "saw" radar emissions, and that could pass along information about the location of the energy source to a control system. And Joe Davis was about to ask them to put it on an airplane.

As Davis watched the Martin laser gun, which had trained its beam on a vehicle about a thousand feet away, automatically follow the vehicle as it moved along a rail, he remembers thinking *We can hit moving targets.* Davis had flown F-84G fighters in Korea, and his first choice for a new technology would be one that could reduce the number of aircraft that were being sent on strike missions. "With the iron bombs we used in Korea, you sometimes had to take 24 ships out to bust a target," Davis says. "If we had to go after a bridge, we had to have at least 12 airplanes to break the bridge." If every bomb hit the target, reasoned Davis, fewer airplanes will be needed to attack.

A 1952 Navy study had reached the same conclusion. Dismayed by the number of strikes required to destroy targets in Korea—and the number of aircraft lost in the process—the Navy Bureau of Aeronautics proposed "using a simple guided missile system to deliver conventional bombs," a rec-

ommendation that led to the development of the Navy's Bullpup missile—manufactured by the Glenn L. Martin Company of Orlando. The early Bullpup's drawbacks were made clear in the first raid on the Than Hoa bridge. Its warhead was too small, its radio guidance system was unreliable, and it required active guiding by the pilot or weapon systems officer flying it with a joystick, who was therefore required to stay in the area until the weapon hit the surface. "A minute can be an awful long time when people are shooting at you," says former AC-130 gunship pilot Dave Mets, an Air Force historian who has written a monograph on the development of laser-guided weapons.

The Pentagon's understandable lack of confidence in the accuracy of its weapons also created a vicious circle of overkill. Because leaders in Washington couldn't be certain a target had been destroyed, they required multiple sorties back to the same place to expend ordnance on phantom structures. "I remember going back to targets in North Vietnam a few times to drop bombs on something that wasn't there," says Nick Lacey, an F-105 pilot who flew strikes against well-protected, entrenched targets during Operation Rolling Thunder, a three-year bombing campaign designed to force the North Vietnamese to the peace table. "Light, shadows, and angle of sight had created an illusion on photo reconnaissance that there was something left, and there was nothing there," Lacey says. "We were just going up north for no reason. We had to face the [surface-to-air missiles] and ground fire all over again for a target that probably had been obliterated days before."

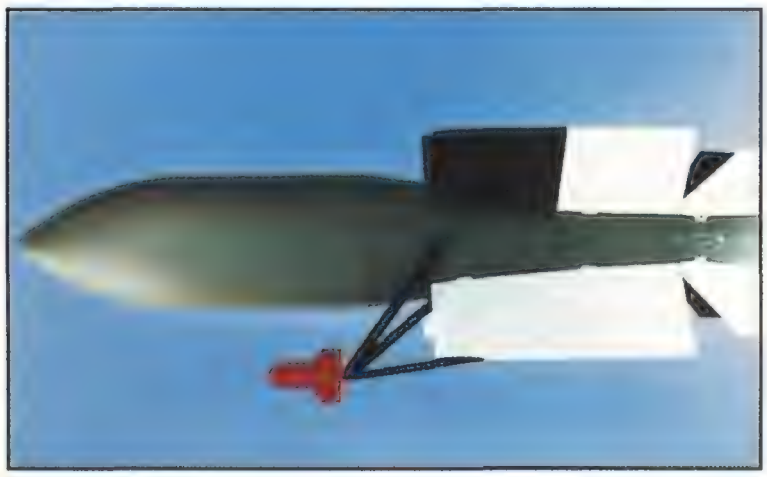
The Air Force needed a weapon that could be dropped from an altitude high enough to keep airmen out of the range of ground fire and one accurate enough to raise confidence and cut out needless trips to a target that had already been destroyed. That's what Joe Davis told Weldon Word when Word visited Eglin Air Force Base looking for business in 1965. Word remembers Davis, by that time the deputy base commander at Eglin, pulling a picture of the Than Hoa bridge out of a desk drawer. "I started counting craters in that photo," says Word. "I stopped when I got to 800 or so, and I never did finish." Davis told Word he wanted a bomb that could be released at middle altitudes. "He wanted to roll in at 18,000 feet—in an F-4—then release the bomb at 10,000 to 13,000 feet and never drop below 8,000 feet. That was mainly above the gun range of the weapons they had over in Vietnam. He said, 'I can get [the bomb] within a thousand feet. Can you do the rest? Can you control the thing from then on?' " Word thought he could. "We married Dave's laser idea to Joe's bomb problem," he recalls.

Davis also told Word that if TI could develop the weapon for $100,000 or less, the colonel would need approval only from a single office at Wright-Patterson Air Force Base, authorized to fund small, fast-track R&D projects without the standard procurement headaches of larger programs. "We were not in the R&D community," says Word. "We were a bastard, backroom program. And eight months after we started, we put holes in the sand."

Davis wanted a dozen guided bombs that would routinely hit within 30 feet of a target. That would beat by a wide margin the average bomb accuracy of the day, which ranged from 100 to 1,000 feet, depending on the tactics, the target, and the weather.

Over a weekend in the summer of 1965, Word embarked on a sleepless 72-hour proposal-writing tear. On Monday, he handed Davis an 18-page hand-written proposal for a laser-guided bomb development program projected to cost $99,000 with a six-month delivery schedule. "Later it turned out to be nothing like what we produced," Word says. "I mean we just had a seeker device basically nailed onto a stabilizer. There was no way it would have flown. It was just a bunch

JIM ROTRAMEL COLLECTION (3)



Loaded for Laos: With two Paveway Mk-84 2,000-pound bombs inboard and 370-gallon fuel tanks outboard, an F-4D heads for the tanker. Left: The original Texas Instruments design mounted the seeker head on a strut; it was quickly moved to the nose.

of junk, but that's where we laid the groundwork, was in that original proposal."

The TI proposal competed with another idea from North American Aviation's Autonetics division. Both had laser detectors that computed the angle between the bomb's actual flight path and a path that would lead it to the target. And both devices passed information to control surfaces: canards, in the case of the North American test article; "slab tails" is how Word characterizes the original, cumbersome control surfaces TI stuck on the aft end of its model. The North American guidance and control units were far more complex, relying on a gyroscope to keep the seeker stable and aligned with the bomb's flightpath and on control surfaces that could deflect through a range of positions providing proportional guidance.

But Davis liked the TI approach. Word says his team had neither the time nor the money to figure out how to use a gyroscope to stabilize the seeker head in space. Instead, TI aeronautical engineer Dick Johnson struck upon the idea of placing the seeker inside the housing of an airflow test probe. The probe resembled a badminton birdie, and the seeker was referred to from then on as the "birdie head." Just aft of the seeker was a ring stabilizer. At rest, the birdie head dangled from the nose of the bomb, where it was connected by a universal joint; in flight, the airflow through the ring kept it aligned in the direction of the bomb's flight path.

"As soon as you get moving parts and gyros," says David Mets, "you're increasing complexity and cost and risk of failure. But Davis had to be a little leery." Mets says that when the military is offered a solution so simple it sounds too good to be true, it usually is. "Sometimes it does work," he adds,

"and it darn well did in that case."

The TI control system was also simpler than the one proposed by North American. The seeker, actually a silicon wafer the size of a half-dollar, was divided into quadrants. It communicated with a set of control fins (later TI also moved the fins forward), which operated in a "bang-bang" or on/off mode: They deflected fully or not at all. Opposing fins, operating in unison, guided the bomb up/down or right/left, depending on the electrical signals received from the detector (see "The Short, Happy Life of a Laser-Guided Bomb, p. 70). "It was easy to pull down," says Word, "but that bastard was harder than hell to pull up. Those bombs were big, old, sluggish fat dudes."

For the flight tests in Florida and even in some early combat trials, TI used bulbous M-117 bombs left over from World War II. When the tests introduced Mk-84 bombs, part of the Mark 80 low-drag bomb series developed by Douglas A-4 Skyhawk designer Ed Heinemann, the accuracy improved by 50 percent.

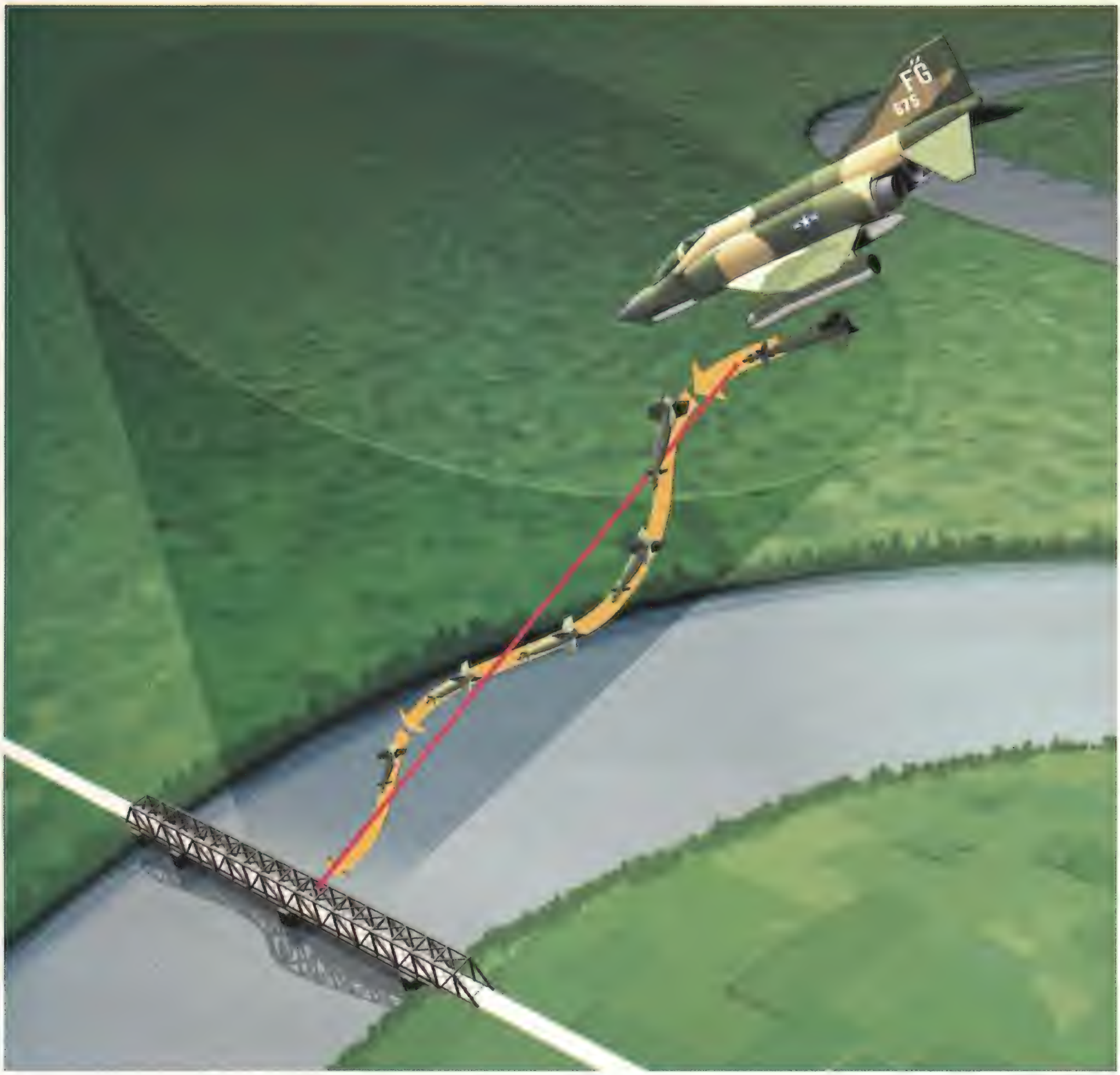
Tom Weaver, a retired TI engineer, remembers one of the most significant challenges the team faced was electronically moving the guidance data from the seeker to the control unit in an era of transistors and circuit boards. "It wasn't so much [developing] the laser as it was working with that slow data rate we had to guide on," Weaver says. "It was only like eight or 10 pulses per second. And as far as data rates go, that's very slow when you are talking about a bomb falling through the air to a target some 6,000 to 8,000 feet away. That data rate problem was one of the biggest challenges to get past." The team finally locked in 10 pulses per second as the golden number to guide a bomb to the target.

Working out of TI's labs in Dallas, Texas, and trudging down to the steamy, jungle-like ranges of Eglin, the team members set out in September 1965 to make laser-guided bombs a reality. Salonimer loaned them a laser, and they used the water tower in Plano, Texas—"the only thing sticking out of the ground," says Word—as a fixed object to measure laser light return.

"We got this thing and we were out on the outskirts of Dallas on about a three-story building," Word recalls. "We were shooting the laser at [the] water tower about a mile away. The only way we could tell the laser worked was to take Polaroid film, hold it with your fingertips, and stick it front of the laser."

The Zot Box laser designator mounted on the rear canopy of an F-4 (left) required the aircraft to orbit the target at 12,000 feet until the bomb it was guiding impacted. With the later Pave Knife system, a small TV screen (bordered by a rubber boot to reduce sun glare) on the left of the backseater's instrument panel was used in guiding the laser's beam.

COURTESY J.D. FRANKS



JOHN MACNEILL (3)

The Short, Happy Life of a Laser-Guided Bomb

The seeker head of a Paveway laser-guided bomb (LGB) has a circular field of view that creates a cone in the sky. The aircraft must be within this cone, or "basket," when the bomb is released if the seeker is to acquire the target. If the bomb is released outside the cone, it will have the ballistic characteristics (and accuracy) of a conventional unguided bomb.

The typical flight of a laser-guided bomb has three phases: (1) the ballistic phase, a very brief period before the seeker acquires the reflected laser energy during which the weapon continues the unguided trajectory imparted by the flight path of the delivery aircraft; (2) the transitional phase—usually three to five seconds—characterized by rapid zig-zagging as the control system attempts to align the LGB's flight path with the seeker's line of sight to the target; and (3) the terminal phase, another five seconds of flight with continuing oscillations.

Because the commands to the control system are on/off—that is, the canards deflect fully or not at all—there are large overshoots of the seeker's line of sight during the first three to five seconds of guided flight. During the terminal phase, once the laser energy momentarily centers on the detector, no guidance commands are generated and the canards stop deflecting. When the energy moves off center again, the canards are again commanded to deflect.

An LGB guidance system computes the difference between the bomb's flight path and the seeker's line of sight. The seeker (opposite, inset) is an array of photodiodes divided into quadrants. As one or two detector quadrants receive more energy, a signal is sent to the appropriate pair of canards to change direction until the energy is centered.

NATIONAL ARCHIVES

A photo taken after the 1972 strike on the Than Hoa bridge shows the west end (left) knocked off its abutment.

There wasn't enough funding for wind tunnel tests, so Dick Johnson made scale models of the fat World War II bombs and tested different-size control surfaces by dropping the models in a swimming pool. "He was trying to get the dart to have stability with the smallest size fins we could make," says Word. "We had to get it under the wing of the airplane."

The tight money situation continued into the flight tests in 1966 and forced the team to be creative in the test approach used at Eglin. Instead of equipping the bombs with instruments to provide telemetry, engineer Nick Baker recalls using flight data recorders in hardened canisters. "That bomb would go down and burrow down and it may go off to the side, and we had to find it to recover this tape recorder," he says. "It looked like we were digging up half the county down there to find the things. You had great big cranes out there digging up all these holes to recover that data."

Word remembers that the first bomb they dropped landed about 140 feet from the target: "Well, we all asked ourselves, 'Did it guide? Or just fall that close?' " The data recorder told them what signals the control system received from the seeker, and helped them figure out that the laser designator was producing satellite beams, fingers of energy projected to the sides of the main beam, and tended to reflect off shrubs or even high grass in front of the target. This explained the inaccuracy of the first tests, and the results improved after the experimenters adjusted the designator.

In the end, Texas Instruments won the contract to produce 50 Paveway laser guidance kits—seeker heads and control systems—to bolt onto conventional bombs already in the Air Force inventory. (The name comes from the acronym PAVE: Precision Avionics Vectoring Equipment.) An advanced version used in low-level attacks today, Paveway III, has a proportional guidance system similar to the original North American design.

So much of the Paveway program was clean-sheet invention that it's surprising to learn that the U.S. Army Air Forces had used radio-guided bombs to destroy bridges in Burma at the end of World War II and bridges in Korea five years later. Those weapons were difficult to use, hard to maintain, and, because of radio control problems, often unreliable.

Although a defense department study at the end of World War II concluded that even with the Norden bombsight, only a tiny fraction of U.S. bombs had come close to their targets, guided-weapon development was neglected in the 1950s. The strategic thinking of the decade focused on nuclear bombs powerful enough to destroy cities, not bridges. "We sucked up 5,000 people working at Eglin in the 1950s on conventional concepts into ICBM programs," says Mets. "Atlas, Titan, Minuteman—where did they get the engineers? You can't build a laser-guided bomb at the same time you're building intercontinental missiles."

Mets points out that when the 1950s doctrine of "massive retaliation" against the Soviet Union gave way to the 1960s principle of "flexible response," the Air Force was ready once again to spend money on improving its aim. "Approaches to this problem have varied from hurling the whole airplane at the target in dive bombing through the de-

NATIONAL ARCHIVES

Situated near a populated area, the Bac Giang power plant was off limits to airstrikes until the Pentagon had confidence that no stray bomb would injure civilians. With Paveway bombs, F-4D Phantoms from the 8th Tactical Fighter Wing scored a direct hit.

velopment of onboard equipment like the Norden bombsight," Mets writes in his study of precision bombing. The final step was "the notion of giving the bomb itself a terminal guidance capability," which saw its most dramatic, early success in the Paveway program.

The Air Force began combat trials of the TI bombs in May 1968. Based on those results, the Paveway kit was redesigned and mated in the summer to the "slick"-shaped Mark-80 series of bombs—just in time for the four-year bombing moratorium begun by President Lyndon Johnson. Until bombing resumed in North Vietnam in 1972, LGBs were used against trucks, roads, gun emplacements, and other targets along the Ho Chi Minh Trail in Laos. Eventually 25,000 were dropped in that country and Vietnam.

On the earliest missions, two aircraft were required to operate the system. A weapon systems officer would use a laser designator mounted on the backseat canopy of one F-4 Phantom to illuminate the target. Another F-4 carrying the LGBs would make the attack dive. In order to keep the target in the field of view of the designator, nicknamed the Zot Box, the pilot of the marking F-4 put his airplane into a left bank around the target at an altitude of 12,000 feet. The predictable flight path made the marking aircraft vulnerable to gunners, especially since the target had to be illuminated until the bomb hit. Little evasive maneuvering was possible because, with the aircraft at a 20,000-foot diagonal distance from the target, a change in bank angle of one degree displaced the center of the laser beam on the ground about 350 feet. Even though no aircraft was lost on a Paveway mission (12,000 feet was above the range of most of the anti-aircraft artillery in Vietnam), the Air Force didn't like risking two aircrews to deliver one load of bombs.

One of the first refinements to the system was a designator pod, Pave Knife, with electronics connecting the laser's aim with that of a TV camera. By sighting the crosshairs of the camera on the target, the WSO also pointed the laser beam at the same place. The designator within the pod was gimballed to rotate so that an attacking aircraft could "paint" a target during its approaching dive and during its pullout after the bomb was released. Only one aircraft was needed; in practice, the F-4 carrying the pod was accompanied by additional attackers, all homing on the same laser spot.

Each Phantom could carry only two 2,000-pound guided bombs because the fixed stabilizing fins (the ones Dick Johnson tested in his swimming pool) allowed only one bomb per station on the fighter. In a later version of the bomb—Paveway II—the aft fins collapsed, allowing two bombs to be loaded on each aircraft bomb station hardpoint, and popped out when the bombs were kicked off the pylon.

The bombs were easy to use but still required piloting skills if they were to be successful. The seeker had a circular field of view, the diameter of which decreased as altitude did; in other words, the view narrowed as the seeker came closer to the target. (Imagine looking through a camera lens as you move toward your subject.) This optical characteristic formed an imaginary cone within which the pilot had to place the bomb in order for it to "see" the laser spot (see "The Short, Happy Life of a Laser-Guided Bomb"). Pilots found that aiming points were far less critical with the new bombs than with unguided ones, since it was necessary only to drop the bomb somewhere within the cone, or "basket," as airmen called it. "You had to be good at what you were doing, there's no doubt about that," says Dean Failor, a retired Air Force lieutenant colonel who used laser-guided

SHELBY G. SPIRES

bombs as a weapon systems officer in F-4s during Vietnam's Linebacker I and II campaigns. "There had to be cooperation between the guy in back and the pilot and a general understanding of how the bomb worked. When you used it properly, the laser-guided bomb was so much better than a regular iron bomb that there is just no comparison."

Just as important to the Air Force, they were cheap. When compared to other "precision" guided weapons available at the time, Paveway I was a frugal investment. The GBU-8 television-guided bombs, which had a higher failure rate, cost the government around $17,000 a piece, but the initial Paveway bombs were priced at around $4,000. And as the production lines geared up near the end of the Vietnam War, the price dropped to $2,500.

Compared to the pay stub of a young Air Force officer of the time, even that seemed expensive. "We used to say we were dropping a Cadillac," says Failor. "They were very accurate and, I guess compared to other munitions of the time, cheap, but to us 'crew dogs' they were Cadillacs. They were worth a Cadillac too, because they worked. We used them for cutting road junctions along the [Ho Chi Minh] Trail, hitting bulldozers, just about all hardened targets, and even destroying tanks. I remember one bulldozer we hit that had been hidden in a bomb crater at a difficult angle [to strike]. We put the laser-guided bomb right on it, and the 'dozer just started tumbling end over end."

The Paveway's performance was degraded by clouds and by haze and smoke from previous bomb runs. The first Paveway systems had no night-time capability. Even with these drawbacks, the bombs racked up a 68 percent kill record.

That record included the Than Hoa bridge. On the morning of May 13, 1972, 14 F-4 Phantoms from the 8th Tactical Fighter Wing took off from Ubon, Thailand. Dropping nine 3,000-pound and 15 2,000-pound Paveway bombs along with 48 conventional 500-pound bombs, they finally knocked the western span of the bridge off its abutment. Also during the Linebacker raids, Paveway bombs dropped a span of the equally vexing Paul Doumer bridge, the connection between Hanoi and China, and put that bridge out of commission for the rest of the war. Moreover, LGBs gave the Pentagon the confidence to go after targets near Hanoi that had been off limits because of the risk that civilians would be killed.

Twenty years later, the same technology offered similar assurances in the 1995 Operation Deliberate Force in Bosnia. The bombs were used to surgically remove artillery emplacements, ammunition storage areas, and command posts from troops that had brought suffering to the people of the former Yugoslavia. U.S. Air Force Captains Brick Izzi and Don Godier, both weapons officers, flew strikes with the 555th Fighter Squadron during Deliberate Force and said the weapons were so accurate they were used less than a mile from civilian structures such as hospitals and apartment complexes, which were not damaged.

"It works as advertised," says Godier, who now flies with the 68th Fighter Squadron at Moody Air Force Base in Georgia. "One of the great things about this weapon overall is that I can...watch my bomb impact, leave the target, get [a Bomb Damage Assessment through the pod], and then go home and tell them that, no kidding, that building is gone."

Many times during the three-week-long Bosnia strikes, Godier saw an attack order that would direct pilots against targets that were no longer there. He or another pilot would bring out the tapes, made by instruments in the pod, and prove the target no longer existed.

Some three decades after finding that initial $100,000 to develop the laser-guided bomb, Word and his TI team had accomplished the goal of not only increasing the accuracy of bombs, but also of reducing the danger to aircrews.

During Desert Storm, F-117s dropped laser-guided bombs on Iraqi aircraft shelters. The result: four shelters, four holes. Opposite: Captain Kevin Raybine checks out a practice variant of a 500-pound LGB loaded on his A-10A "Warthog."

JIM ROTRAMEL COLLECTION

>SIGHTINGS<

MICHAEL MELFORD (2)

All the rage in the late 1920s, the autogiro took a nosedive in the Great Depression. Juan de la Cierva's stall-proof craft had introduced features like rotor blade hinges, which ultimately led to the success of the helicopter (see "The Autogiro and Its Legacy," Dec. 1989/Jan. 1990), rendering the autogiro a nostalgic artifact that survives today only through the efforts of homebuilders.

Hank Hinchman first built an autogiro from a kit, then designed his H-1 Racer (not to be confused with Howard Hughes' sleek monoplane of the same name—and it's not likely to be). "It's a breed of its own," Hinchman says. "I got into it because of the safety factor. If I get behind the power curve, I can pull the stick back and it'll fall straight down at the rate of a parachute. And it's more maneuverable than an airplane. I could even land in my back yard." Indeed, in the autogiro's heyday, a *New Yorker* writer noted: "And although it looks like something Jules Verne thought of, it will actually land in one's flower garden—or, if one is fussy, in one's neighbor's flower garden."

HEAVENLY VIEW

Seeing and Believing: How the Telescope Opened Our Eyes and Minds to the Heavens
by Richard Panek. Viking, 1998. 198 pp., $21.95 (hardcover).

NASA

The Hubble Space Telescope is readied for its 1990 launch. Flawed optics would be repaired by shuttle astronauts in 1993.

This surprisingly good little book charts the history of the use of the telescope in terms anyone can understand and will enjoy. The context is more cultural than technical. Richard Panek, a writer of both fiction and social history, recounts how improvements in the telescope over nearly 400 years have created technical capabilities that have yielded ever-changing views of what the universe is, and where we are in it.

For countless centuries, every human culture acted as if it were the center of its universe. The astronomical evidence was incontrovertible: The sun, moon, planets and stars all appeared to move around us. We felt none of this motion; accordingly, we had to be at the center. Anomalies in the motions of the planets and logical deduction led a few Greek philosophers to speculate that Earth indeed moved about the sun. In the 16th century, Copernicus revived the idea because it helped him preserve perfect circular motion in the heavens and allowed him to construct a simpler, more elegant geometrical model to describe planetary motion. Copernicus' construction of the heavens was interesting as a mathematical exercise and enjoyed a slowly growing influence. The real drama began, however, in the early 17th century, when Galileo and others began directing the newly invented telescope to the heavens to find that indeed, Earth was not the only center of motion in the heavens. Jupiter had moons; Venus exhibited phases; the sun and moon had surface features; stars invisible to the unaided eye were rendered visible. All these observations indicated that we lived in a physical, material universe. The moon and planets were solid objects much like Earth, with mountains and seas. Bolstered by telescopic views, heliocentrism eventually became our dominant world view.

Stimulated by Galileo's spectacular discoveries, astronomers began to use the telescope for observations, but not all embraced its powers. Panek sensitively shows that in the mid-17th century, Johannes Hevelius resisted using it to determine the positions of stars, and instead upheld the visual tradition, even though he also built some of the largest telescopes in the world. Nicely delineated are all the technical problems of making better telescopes in the 17th and 18th centuries, and how telescope builders eventually learned how to construct compound (or achromatic) lenses to free the image from spurious colors and other aberrations. Making large lenses was difficult, which made many observers turn to reflecting telescopes employing metal mirrors. This development provides the author's primary thread as he chronicles the production of the giant telescopes (giant in terms of light gathering power, not just magnification) by William Herschel and his son John and, in the mid-19th century, William Parsons, the Earl of Rosse. Herschel was the first modern cosmologist to devise a means to estimate the extent of the universe, using his great telescopes to count stars and meticulously describe the enigmatic nebulae. Rosse discovered that some of the nebulae were spiral in shape. Their true cosmological significance was settled in the 1920s when Edwin Hubble showed, from photographic and spectroscopic observations with the 100-inch Mount Wilson reflector in southern California, that galaxies exist and that they are moving away from one another. A few years prior, at the same observatory, Harlow Shapley had shown for the first time that the sun and solar system could not be at the center of the Milky Way galaxy. Hubble followed suit, showing that the Milky Way was only one galaxy (or "island universe") among a vast sea of galaxies.

Today, astronomers work in the general framework established by Shapley and Hubble. The universe of

galaxies appears to be expanding, and there is no center. All the wonderful new telescopes Panek goes on to describe, from ground-based optical and non-optical monsters to orbiting observatories like the Hubble Space Telescope, are constantly refining this picture, but at the young age of 70 years, it remains fundamentally the same picture. Even so, there are many weird and wild things about the universe never dreamt of in Hubble's time that have been detected, or indirectly suggested, by the new telescopes: primordial radiation, black holes, bubbles and voids, gamma-ray bursters, quasi-stellar radio sources, and dark matter. Most support the framework of Hubble's universe, but not all do in ways that satisfy all astronomers. Will this 70-year-old master narrative change again? Although Panek does not say, he provides a conceptual and philosophical appreciation of the role of technology in discovery that will help any motivated reader better understand why, even though astronomers always want to build bigger and more powerful telescopes, it takes more than bigger telescopes to build new universes.

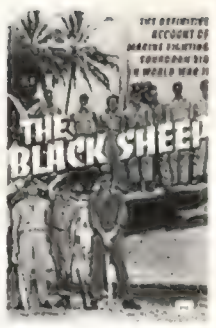
Although there are a few unimportant blunders (none of more than antiquarian interest), Panek's careful use of a robust historical literature makes *Seeing and Believing* a generally reliable introduction to the history of telescopic astronomy and key astronomers.

—David DeVorkin is curator of the history of astronomy and the space sciences at the National Air and Space Museum.

The Black Sheep: The Definitive Account of Marine Fighting Squadron 214 in World War II *by Bruce Gamble. Presidio, 1998. 496 pp., maps and b&w photos, $28.95 (hardcover).*

To the small list of Americans who use Japanese sources to study the Pacific War, add Bruce Gamble's name. His meticulous history recounts the three lives of VMF-214, which first saw combat at Guadalcanal as the Swashbucklers. The squadron number was then attached to a different outfit, commanded by a hard-drinking, belligerent former Flying Tiger named Gregory Boyington. The fighting name changed also: As the Black Sheep, VMF-214 fought up the "slot" of the Solomon Islands, its leader as intent upon becoming the top-ranking Marine fighter ace as he was in prosecuting the war in the Pacific.

Some readers may lose interest after Boyington disappears into Japanese



captivity. A mistake: VMF-214 was reconstituted as a carrier-borne squadron to defend U.S. ships against kamikazes. Its death by fire, explosion, and drowning on its first day of combat is one of the most harrowing stories to emerge from the war.

As a former naval flight officer, Gamble may escape the fury visited upon writers who compare American claims to Japanese accounts (full disclosure: I did that for *Flying Tigers: Claire Chennault and the American Volunteer Group*, with incendiary results). He further insulates himself by giving respectful attention to each Marine's combat narrative, only later revealing that most victories were illusory. For example, the Black Sheep took credit for destroying 26 aircraft on December 28, 1943, when only three Japanese pilots failed to return from combat.

Overall, VMF-214 was credited with 160 combat kills. Gamble concludes that perhaps a third of these were real, a rate comparing favorably with those of other Western air forces in World War II.

—Daniel Ford is the author of Glen Edwards: A Bomber Pilot's Diary, *just out from Smithsonian Institution Press.*

European Air War. *MicroProse, www.microprose.com, (800) 400-1352, $49.99.*

Although it's been languishing on the drawing boards for several years, *European Air War* (*EAW*), the eagerly awaited sequel to MicroProse's *1942: The Pacific Air War*, has finally hit the streets.

More than 20 types of World War II aircraft are modeled, from the long-range P-51D Mustang to the jet-powered Me 262 *Stürmvogel*, with several derivatives thrown in for good measure. Other aircraft, such as the Boeing B-17 Flying Fortress and the Heinkel He-111 medium bomber, are depicted too, although these aircraft cannot be flown by the player.

In addition to a quick combat mode, *EAW* contains three campaign games, one covering the epic Battle of Britain and the other two depicting the struggle to control the skies over Europe in 1943 and again in 1944. Each campaign has been dynamically constructed, which in effect means that the player's outcome in one mission will directly affect all of the parameters for the next mission. Several dozen single missions are also included, all of which can be modified prior to takeoff to let the player change the competency level for both friendly and enemy pilots as well as the type of aircraft involved.

From an aesthetic standpoint, *EAW* is outstanding, melding graphics, sound effects, and period music to form a near-perfect World War II flight simulation. The flight and damage modeling are equally well handled, as are the effects of flak, gunfire, wind, and sun glare. Each aircraft is beautifully defined, featuring photo-realistic instrument panels, fully articulated control surfaces, and authentic-looking exteriors as well as numerous internal and external viewing perspectives. All in all, *EAW* is a superb effort. Best of all, it can be played against fellow air combat enthusiasts either over a network or across the Internet.

Microsoft Combat Flight Simulator. *Microsoft, www.microsoft.com, (425) 882-8080, $49.99.*

Fans of Microsoft's hyper-realistic *Flight Simulator* general aviation series will be happy to learn that the company has finally decided to toss its goggles and, more importantly, its marketing power into the combat simulation ring with the release of *Combat Flight Simulator* (*CFS*). To their credit, the designers have produced what is perhaps one of the most realistic air combat simulations ever crafted, employing their award-winning *Flight Simulator '98* game engine as the basis for many of the features found in *CFS*.

Although there are eight highly detailed aircraft, drawn from the Royal Air Force, U.S. Army Air Forces, and the Luftwaffe to fly, players do have the option of importing other *Flight Simulator '98* aircraft and can add everything from jets to prop-driven commercial aircraft and, if they choose, can even attach weapons to the aircraft, creating some bizarre engagements, such as a rocket-equipped 747 chasing a Bf 109.

CFS' other strong point is its terrain modeling. The rolling countryside of Europe is rendered in exquisite and painstaking detail, with three cities—London, Paris, and Berlin—modeled in 3-D. Like the aircraft, additional terrain can be imported, using any of the commercially available scenery packs supplied by various third party distributors.

Two campaign games are included, one addressing the Battle of Britain, from July 1940 to October 1940, while the other examines the ensuing "Battle for Europe," from June 1943 to April 1945, with each campaign divided into three phases. Unlike *EAW*, each mission in *CFS* has been scripted, which means that the player must fight the same series of missions in exactly the same manner no matter how he has fared in previous battles. Given the nature of the conflict, this can pose problems. Additionally, several dozen historical missions have been included as well as a Quick Combat mode, which lets players jump into their favorite aircraft to duke it out against a sky full of dozens of enemy aircraft.

While *CFS* is indeed a commendable effort, Microsoft did manage to drop the ball on a number of counts. For starters, the enemy aircraft, even at the toughest setting, aren't all that challenging, time and again opting to chase after friendly aircraft other than the one the player is flying. To make matters worse, radio communication is impossible, so there's no way to communicate with your wingmen. While *CFS* does manage to get some things right, it ends up lagging behind the competition in several critical areas.

Jane's WWII Fighters. *Electronic Arts, www.ea.janes.com, (800) 245-4525, $49.99.*

Produced in conjunction with Jane's, *WWII Fighters* is perhaps the most limited in scope of the three titles profiled here, covering the air war in Europe during the climactic year of 1944. To compensate, the product does contain a collection of period film footage as well as interviews with six combat aces, including "Bud" Anderson, who helped Electronic Arts design the game.

WWII Fighters implements many of the same features found in the now-classic *Chuck Yeager Air Combat*, employing independent viewing windows to track enemy aircraft as well as other inflight aids. The graphics are awe-inspiring, complete with billowy cloud layers and translucent smoke trails, although it should be pointed out that the game requires a 3-D accelerator card, whereas the other games reviewed here can, if need be, get by on Windows Direct 3D. Game play is equally impressive; however, only seven aircraft are modeled, all taken from the airfields of the Luftwaffe and the U.S. Army Air Forces.

WWII Fighters features a branching campaign structure, although here again each of the missions is scripted. Lots of training scenarios and other independent missions are included, as well as an online multi-player mode that hooks into the Jane's Combat Net Web site (www.janescombat.net). All things considered, *WWII Fighters* is a fine addition to any air combat enthusiast's game library.

—Marc Dultz is a freelance computer game reviewer.

Jannus, an American Flyer *by Thomas Reilly. University Press of Florida, 1997. 236 pp., b&w photos, $29.95.*

Many aviation enthusiasts know that Tony Jannus became the first airline pilot when, on New Year's Day, 1914, he departed St. Petersburg, Florida, for Tampa on the world's first scheduled airline flight. Most of us don't know a whole lot more about Jannus. Thomas Reilly sets out to overcome this—not an easy matter, since Jannus flew for less than six years, and was only 27 when he fatally crashed in Russia 83 years ago. Fortunately, flying was a newsworthy novelty early in the century, and Reilly combed newspapers and periodicals for his research.

Born in June 1889, Jannus was orphaned at 13. Raised by an aunt and uncle, he graduated from technical high school in Washington, D.C., in 1908 and was hired by Emerson Marine Engine Company in Alexandria, Virginia. When Rexford Smith needed an engine for his newly built airplane, Emerson supplied one and sent Jannus to install it. It was during this errand that Jannus made his

ON THE TUBE

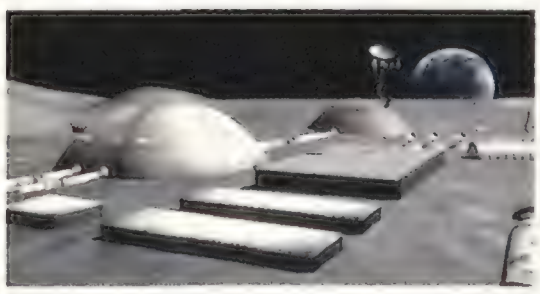
Cybercopter. *Premieres 8:00 p.m. EST, Thurs., April 1, 1999, on Discovery Channel.*

Search and Rescue: The Story of the B-24 Bomber. *Premieres 8:00 p.m. EST, Sun., April 18, 1999, on Discovery Channel.*

Cybercopter examines 21st century warfare, while *Search and Rescue* tells the story of a B-24 crash site recently discovered in China.

Voyage to the Milky Way. *Premieres 8:00 p.m. EST, Wed., May 19, 1999, on PBS.*

This two-hour special (below) examines the future of space exploration, including the challenges of long-range space travel. The first hour reviews the probes and telescopes that have increased our understanding of the solar system. The second half examines new propulsion systems, including laser beams and ion streams.



first flight, piloting Smith's plane at College Park, Maryland, in November 1910. Self-taught, Jannus progressed rapidly, but in May 1911 he broke his collarbone in a crash in Bristol, Virginia.

In November 1911, after a year of flying, Tony Jannus became the chief pilot for Tom Benoist in St. Louis. Benoist, 15 years older, had first flown only two months earlier than Jannus had, but by late 1911 he was building airplanes and operating a flight school. For two years Jannus performed aerial demonstrations and undertook adventures in Benoist's aircraft throughout the Midwest and as far east as New York City and as far south as New Orleans. Then a third pioneer entered their lives. In December 1913, Percival Fansler contracted with Benoist and St. Petersburg businessmen to operate the St. Petersburg-Tampa Airboat Line for the first three months of 1914.

While barely 20 miles of water separated the two cities, there were only two ways you could get from one to the other: an hours-long boat ride or an even longer 64-mile train trip. It was a situation Tampa preferred not to disturb, but St. Petersburg businessmen were so enthusiastic over Fansler's idea that they agreed to subsidize his airline's twice-daily round trips (the $5 one-way fare was insufficient to cover Fansler's costs). Tony Jannus became the pilot of this first scheduled airline. Shortly after Fansler's airline ended operations, Jannus left Benoist and undertook a series of aerial endeavors, often with his older brother Roger. In the spring of 1915, Jannus was hired as a test pilot by Canadian Curtiss, and in October 1915 he sailed to Russia to help deliver 50 Curtiss Model K flying boats to the czar's navy. He was sent there again in April 1916 to test two twin-engine Curtiss flying boats and to get the troubled Model K boats working.

These exciting lives did not have happy endings. Jannus and two Russians died on October 12, 1916, when their airplane crashed into the Black Sea. From the Russian account reported by Reilly, I surmise Jannus fell victim to the classic stall-spin scenario, but Reilly blames mechanical failure. In June 1917, Tom Benoist, having built more than 100 aircraft in slightly more than six years, died in a freak streetcar accident. Roger Jannus' end came in September 1918, when the de Havilland DH-4 he was flying in exploded over France.

Reilly has done a good job of fleshing out the short, eventful life of an important pioneer aviator. He scrupulously documents his research with end notes and an extensive bibliography, a real service to historians. He illustrates the text with 50 interesting photos, some of which show that Benoist assigned the designation "Type XII" to machines with entirely different fuselage designs. (NASM's Benoist type XII is on exhibit at the Garber facility in Suitland, Maryland.) I found the book quite well written but marred by some flaws, which I believe stem from Reilly's being sabotaged by his sources—journalists of more than 80 years ago. On page 98, we find the third example of a pilot taking off "with the wind at his back." In this case, Reilly notes that the "account is suspect." It's too bad that Reilly wasn't more critical of his sources, because his book is a valuable contribution to early aviation history.

—Sam Smith is a commercially licensed pilot and amateur aviation historian.

VIDEO ROUNDUP

John Glenn: An American Legend *MPI Media (800-777-2223), $19.98.*

Includes historic footage of Glenn's 1962 orbital flight, as well as his recent flight as a space shuttle crewmember.

Hunters in the Sky: Fighter Aces of World War II *GoodTimes Home Video (800-369-5588). Five-volume series, $59.95.*

A five-part series, hosted by Cliff Robertson, that highlights well-known World War II aerial battles and aircraft. Includes a 64-page book of color photos and an aircraft identification poster.

The Big Space Shuttle *Little Mammoth Media (800-543-8433), $14.95.*

Designed for children ages 3 through 8, *Space Shuttle* includes segments on astronaut training and missions. Other titles available: *The Big Plane Trip* and *The Big Aircraft Carrier.*

CREDITS

MiG Fever. John Lowery retired from the U.S. Air Force in 1975. During the Korean War, he flew 45 combat missions in the Sabrejet and 120 combat missions in the F-105D Thunderchief. For the past 24 years he has been president of Execjet Training Associates, Inc.

Swordplay. William K. Kershner is the author of numerous flight training books, including *The Student Pilot's Flight Manual*, which has sold some 780,000 copies. He was recently inducted into the Flight Instructor Hall of Fame.

Launch. Inflate. Insert Crew. Marcia Dunn is a wire service reporter who covers the space program from Cape Canaveral, Florida.

One Helluva Roar. Nan K. Chase is a freelance writer based in western North Carolina. She compiles the monthly Travel News column for *Hemispheres*, the inflight magazine of United Airlines.

The Great American Airshow. David Peters is an aviation enthusiast who is currently metamorphosing from a mere spectator into a real aviator.

The Voice. Contributing editor Frank Kuznik declined to race Big Bubinski at last year's Oceana airshow; he did, however, overindulge at the kielbasa stand.

Lifeline. Freelance writer Carl Hoffman contributes frequently to *Air & Space*. He felt safer flying in and out of Lokichokio, despite its primitive conditions, than he does out of Reagan Washington National.

The Year the Rockets Came. Gary L. Harris is a project engineer for Weaver Aerospace Company and a staff member of the Cape Canaveral Air Force Space and Missile Museum. Harris wishes to acknowledge the contributions of historian and photo researcher Al Hartman and historian Cliff Lethbridge to this article.

Guiding Light. Shelby G. Spires is a military correspondent, photographer, and editor for Thomson Newspapers. Based in Valdosta, Georgia, Spires has spent the past five years writing and reporting on the U.S. Air Force.

Yankee Memories. Lester A. Reingold is a frequent contributor. For the Dec. 1998/ Jan. 1999 issue, he wrote a short article on Virgin Atlantic Airways founder Richard Branson.

CALENDAR

April 7–10
National Congress on Aviation and Space Education. Sponsored by the Civil Air Patrol. Omni Rosen Hotel, Orlando, FL, (800) 204-7234.

April 20–22
Aviation Services & Suppliers Super Show. Phoenix Convention Center at Civic Plaza, Phoenix, AZ, (703) 845-9000.

April 24
Reunion: Santa Ana Army Air Base Wing. Orange Coast College, Costa Mesa, CA, (949) 631-5918.

April 24 & 25
Charlie Wells Fly-In Breakfast. Sponsored by the Prairie Aviation Museum. Capitol Airport, Springfield, IL, (309) 663-7632.

April 25–May 2
15th Annual Great Southern Air Race. Sponsored by the Florida Race Pilots Association. Marathon, Florida, (904) 325-3175.

April 27–29
Corporate Aviation Safety Seminar. Sponsored by the Flight Safety Foundation. Hyatt Regency, Cincinnati, OH, (703) 739-6700.

May 1
EAA Chapter 690 Fly-In Pancake Breakfast. Sport Aviation Center, Briscoe Field, Lawrenceville, GA, (770) 394-5466.

May 1 & 2
Toronto Aviation & Aircraft Show. The Hangar at Downsview Airport, Toronto, Ontario, Canada, (519) 856-9843.

May 6
Space Day. This year's event will kick off on the National Mall in Washington, D.C., and will feature a virtual reality adventure aboard a space shuttle replica, an electronic field trip broadcast live to schoolchildren, and Cyber Space Day, a live interactive Webcast. For more information, visit the World Wide Web at www.spaceday.com or call Devillier Communications at (202) 833-8121.

May 10 & 11
First World Summit on the Space Transportation Business. Inter-Continental Hotel, Paris, France, phone 33 (0)1 49 23 75 30.

May 12–15
Aircraft Electronics Association Convention and Trade Show. Hyatt Regency, Atlanta, GA, (816) 373-6565.

May 15 & 16
Upson Airshow & Business Expo. Thomaston, GA, (706) 648-6385.

May 18–22
Reunion: USS *Block Island* CVE 21:106 and all air groups. Reno, NV, (541) 345-7019.

May 19–23
Reunion: 446th Bomb Group, 8th Air Force, World War II. Viscount Suite Hotel, Tucson, AZ, (520) 296-4829.

May 22
Prairie Aviation Museum Fly-In Breakfast. Central Illinois Regional Airport, Bloomington, IL, (309) 663-7632.

May 22 & 23
EAA Chapter 186 Fly-In Pancake Breakfast. Winchester Regional Airport, VA, (703) 780-6329.

May 29 & 30
Muskoka International Airshow. Muskoka, Ontario, Canada, (705) 687-1620, e-mail: airshow@muskoka.com.

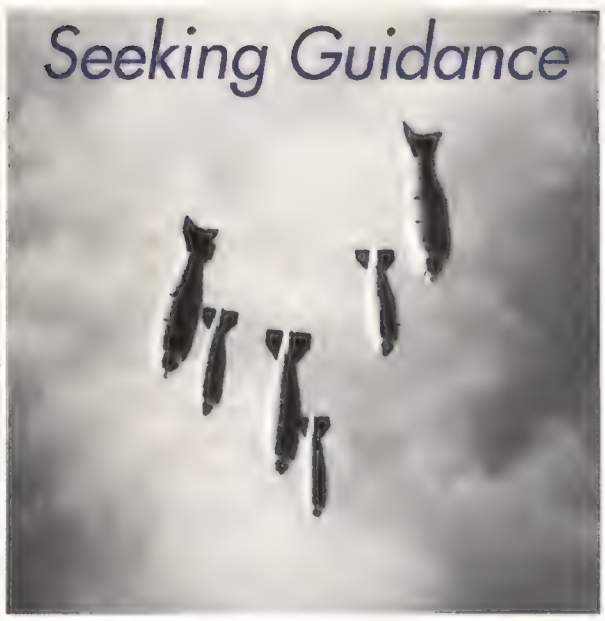
World's Smallest Airshow. Ultralight demonstrations. Brian Ranch Airport, Llano, CA, (661) 261-3216.

The Great American Airshow

Poster Key

1. Canadian Forces Snowbirds (CT-114 Tutor)
2. Northern Lights Aerobatic Team (Extra 300)
3. U.S. Navy Blue Angels (F/A-18)
4. Sean D. Tucker (Challenger II)
5. Joann Osterud (Ultimate 10-300S)
6. Northrop Grumman B-2 Spirit
7. Paul McGowan Airshows Skydivers
8. Eddie Andreini Airshows (Yak-9)
9. Aviat Pitts S2C Demonstration
10. Chip Beck Aerobatics (Glasair III)
11. The French Connection (CAP 10)
12. North American Aerobatic Team (T-6)
13. Gee Bee R-2 Racer Replica
14. Bob Hoover (Shrike Aero Commander)
15. Wayne Handley Raven (Rebel 2300)
16. Aerial Allstars Skydiving Team
17. Patty Wagstaff Airshows (Extra 300S)
18. Julie Clark's American Aerobatics (T-34)
19. Jim Franklin (Waco Mystery Ship)
20. U.S. Air Force Thunderbirds (F-16)
21. Bob Bishop Freedom Jet Team (BD-5J)
22. Lima Lima Flight Team (T-34)
23. U.S. Navy F-14 Demonstration
24. Liberty Parachute Team
25. Lee Lauderback Stallion 51 Corp. (P-51)
26. Red Baron Squadron (Stearman)
27. Frank Ryder (Super Chipmunk)
28. Lockheed C-130 Hercules
29. Red Eagle Airshows (Christen Eagle)
30. Mohr Barnstorming (Enstrom F-28)
31. Diamonds (North American SNJ)
32. Save-A-Connie (Super Constellation)
33. Jim Cheatham Aloha Copter (Robinson R-22)
34. Intrepid Racing (MiG-15)
35. Tora Tora Tora (Kate, Val, Zero replicas)
36. U.S. Army Golden Knights
37. Gene Soucy Airshows (Extra 300S)
38. Otis Spunkmeyer Air (DC-3)
39. Smoke-n-Thunder
40. U.S. Army Airborne Demonstration

ON THE WEB SITE



GENERAL PURPOSE BOMBS, 1968/U.S. AIR FORCE

During World War II, both the U.S. Navy and the Army Air Forces, frustrated by the number of missions it took to destroy targets with conventional bombs, experimented with guided weapons. Among the early guided bombs was a Korean War-era behemoth, the 12,000-pound Tarzon, too big for even a B-29's bomb bay. (The airplane was modified to carry the weapon with part of it protruding.) For more information about these first attempts at getting bombs closer to their targets, visit the Web at www.airspacemag.com/ASM/mag/supp/AM99/Paveway.html

FORECAST

In the Wings...

Y2K—Will U Fly?
An unhysterical investigation shows that you may not want to, even though aviation as we know it will *not* come to an end when those zeros roll around.

Seeing ET.
The search for extraterrestrial intelligence continues—in the visible range of the spectrum.

The Kookaburra Incident.
On a flight across the Outback in 1929, Charles Kingsford-Smith, Australia's Lindbergh, was forced by weather to land in the inhospitable Tanami Desert. During the two weeks he was missing, a series of mishaps turned his eventual rescue into an aviation scandal.

"UNIDENTIFIED FLYING OBJECT" OFFICIAL CONTEST RULES

1) NO PURCHASE NECESSARY

2) To enter hand print on a 3 1/2" x 5 1/2" postcard your name, address and telephone number, date of the issue cover, correctly identify the "unidentified flying object" illustrated, and be sure to follow instructions on the feature page. No mechanically reproduced entries permitted. You may enter as many times as you wish, but each entry must be mailed separately.

3) Each entry must be postmarked no later than the last day of the month on the issue cover and received by the 10th of the month following the issue date. Mail entries to: Air & Space/Smithsonian Magazine Contest, 901 D Street SW, 10th Floor, Washington DC 20024.

4) Six contests: (1) December 1998-January 1999, (2) February-March, (3) April-May, (4) June-July, (5) August-September, (6) October-November 1999 issues.

5) One winner will be randomly selected from all correctly answered entries from each of the six contests by Marden-Kane, Inc. an independent judging organization whose decision in all matters relating to the rules and administration of the contest is final and binding. Each of the six contests' winners will be awarded a Garmin 111 Handheld Satellite Navigator, approximate retail value $350.00 each.

6) SECOND CHANCE GRAND PRIZE DRAWING. In addition to the prize awards for the six contests, a "second chance" random Grand Prize drawing will take place on December 10, 1999. All eligible entries from all six contests will be automatically entered in the Grand Prize drawing. The prize...a $2,000 voucher for flight training provided by G. A. Team partner flight training facility. Winner will be provided with a list of facility locations. Transportation to and from the facility not included. Total A.R.V. of prizes $4,100.00.

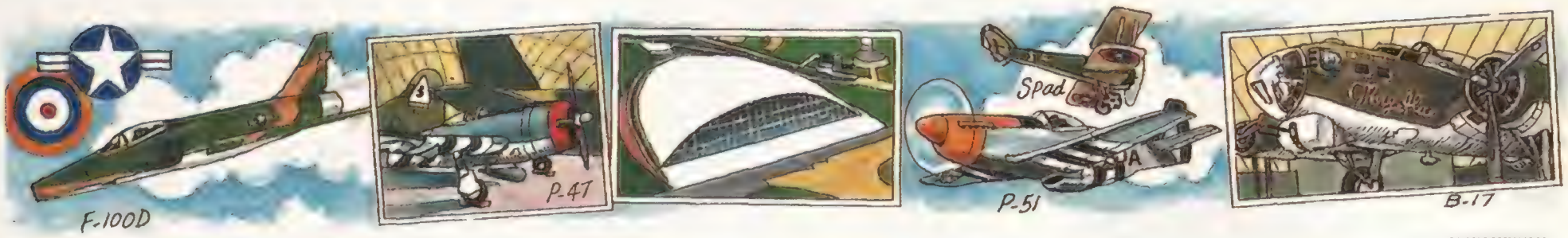
7) Winners will be notified by mail. All entries become the property of Air & Space and none will be acknowledged or returned. Contest open to legal residents of the U.S. and Canada 18 years of age or older at time of entry. Void in Quebec and Puerto Rico and wherever prohibited. Employees of Smithsonian Institution, advertising and promotional agencies, contributors to Air & Space and their families not eligible. Canadian winners will be required to answer an arithmetical skill question administered by mail.

8) Odds of winning each contest dependent on the number of correct entries. Taxes, if any, are the sole responsibility of the prize winner. All Federal, State, local and provincial laws apply.

9) Sponsor not responsible for damage, losses or injury resulting from the use and acceptance of a prize. Winners consent to use of name and/or likeness for editorials, advertising and promotion purposes without further compensation, except where prohibited by law. No substitution or transfer of prize permitted.

10) For a complete winner's list, available after December 10, 1999, send a stamped, self-addressed envelope to Air & Space "Unidentified Flying Object" Contest Winners, 901 D Street SW, 10th Floor, Washington DC 20024

Sponsor: Air & Space/Smithsonian Magazine, 901 D Street SW, 10th Floor, Washington DC 20024.



JOHN HEINLY

Yankee Memories

A museum filled with artifacts of the United States at war now stands an ocean away from U.S. soil. It is the American Air Museum in Britain, which opened in 1997 at Duxford Airfield, about 50 miles north of London.

The museum is an addition to one that had been established earlier at Duxford to display aircraft and other large exhibits of the London-based Imperial War Museum. The new facility is architecturally distinct; at the rear you see only a slight rise where the building wells up gently from the surrounding hillside, but at the front it looks like a dramatic, glass-fronted hangar. That's fitting, because Duxford is a working airfield, home to a collection of privately owned historic aircraft that are still flown. The American Air Museum faces the flightline, so a visitor can look at the B-17 on display inside, even peer through an opening to the interior, then look outside and see another B-17 on a takeoff roll. When a P-51 streaks low over the deck, its high whine is unmistakable. And in May, July, September, and October, the base hosts airshows featuring World War II and other aircraft. "It's really an essential component of what Duxford is about, to have technology here that still works," says Stephen Woolford, head of education and exhibitions.

Duxford has served as an airfield for almost a century. The Royal Air Force used it in World War I, and in the Second World War it was used first by the British, then by the Americans. The new museum was conceived primarily as a tribute to the Anglo-American effort that destroyed Hitler, and to the role this region had in that massive air offensive. A lighted map shows that Duxford was just one of scores of U.S. and British bases clustered in and around East Anglia, the region nearest Nazi-occupied Europe. "That map shows just how incredibly thick on the ground U.S. units were in this part of England," says Ted Inman, director of the museum. At one point, nearly half a million U.S. airmen were stationed in England.

The museum includes artifacts from other conflicts: the Pacific theater, World War I, the cold war, the Gulf War. The museum's B-29A saw action in both World War II (against Japan) and the Korean War. And the first airplane visitors see upon entering the building is a Vietnam-era B-52D, which dominates all other airplanes in the collection. (Indeed, the building was designed to fit snugly around the Stratofortress.)

Eight of the museum's 21 aircraft are suspended in various flight attitudes. The 10-ton F-100D is in a steep attack dive. The U-2C climbs high over a Soviet SA-2 surface-to-air missile, the type that brought down Francis Gary Powers' U-2 reconnaissance airplane in 1960.

The American Air Museum in Britain, Duxford Airfield, Duxford, Cambridge CB2 4QR, England. Phone 01223 835 000. Web site: www.iwm.org.uk/america.htm. Open daily, 10 a.m.–6 p.m., Mar. 14–Oct. 24; 10 a.m.–4 p.m. the rest of year. Closed Dec. 24–26. Admission: adults, £7.20 (about $11.50); seniors, £5; kids, free.

As for the floor-level exhibits, there's little standing between them and the museum's visitors. "Our philosophy in the past was to put barriers around things," says Inman. "But I think it's right to let people get close." On a recent visit, a group of schoolchildren swarmed over the A-10 Thunderbolt II, climbing onto the landing gear and squeezing fingers into the barrels of its cannon.

One of the more unusual displays is a massive cylinder of polished steel, with a thick collar at each end. It is one of 26 sections of a 512-foot Iraqi "supergun" that was to be built into a mountainside. It would have been the world's largest artillery piece, capable of firing a one-ton shell hundreds of miles.

The museum's collection is not limited to aircraft and armament. One case displays uniforms, including those of two commanding generals of the Eighth Air Force, Ira Eaker and James Doolittle. And there are samples of the chocolate, nylon stockings, and cigarettes that U.S. Army Air Forces personnel brought with them during World War II, commodities long absent in besieged Britain.

The displays also include more somber artifacts: the burned remains of a parachute used by a B-17 crew member who had to bail out over France, as well as the Air Medal and Purple Heart awarded to Kenneth L. Dilts, a gunner whose turret was raked by fire from a German Focke-Wulf 190.

In the gallery where these objects are exhibited, one visitor, Jim Church, recalled witnessing such losses from the perspective of what he called a "ground pounder." He was in an Army unit that landed at Normandy and was fighting its way across Western Europe. One of his buddies had a brother who flew P-47s. One day, when the unit was at the Meuse River, that pilot came in low and rocked his wing in a greeting to his brother. "Just then an Me 109 came out of the sun and got him," says Church. "As we all watched, he exploded."

Duxford's new museum does not neglect such casualties of air power. In one gallery, two memorial walls are covered with names from the Eighth Air Force (more names will be added, including those of the Ninth). The theme of remembrance is established even before visitors enter the museum: Lining the walkway to the entrance is a sculpture called "Counting the Cost," composed of glass panels etched with figures that represent each of the 7,031 Britain-based American aircraft that were lost in World War II.

There is another way to count the cost. A fitting conclusion for a visit to the American Air Museum is to take a short drive from Duxford to a place called Madingley. The small cross-like airplane figures seen earlier on the glass panels are echoed at Madingley by larger white crosses. They stand in long rows curving gently around a hillside—3,812 Americans who came to Britain and never went home.

—Lester A. Reingold

Drive through Kansas and you'll miss it.

It has been said that Kansas has so much sky people just naturally look up. So much sky that dreamers and explorers are challenged to test the limits. More astronauts were born in the midwest than any other part of America. And aviatrix Amelia Earhart called Kansas home. This rich heritage of American aviation, perhaps inspired by the boundless Kansas sky, is one of many facets of the state's personality overlooked by travelers as they fly through fields of golden wheat in their haste to reach the far horizon. While just out of sight, just beyond the next ridge, lies a Kansas brimming with history, natural wonder, flights of fancy. Drive through Kansas and you'll get where you're going. Stop and stay awhile, and you'll see what you've been missing.

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AIR&SPACE
Smithsonian

Photo illustration by David Peters
A supplement to the April/May 1999 issue of Air & Space/Smithsonian

See page 82 for a key to the aircraft and performers shown here

The Great American Airshow

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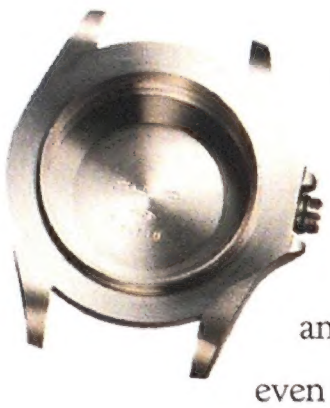

impenetrable miniature vault which, for this Submariner, is pressure-proof to 1,000 feet. Its legendary durability has made it the standard of excellence among divers, and is just one reason why this timepiece grows even more impressive the deeper you delve into it.

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